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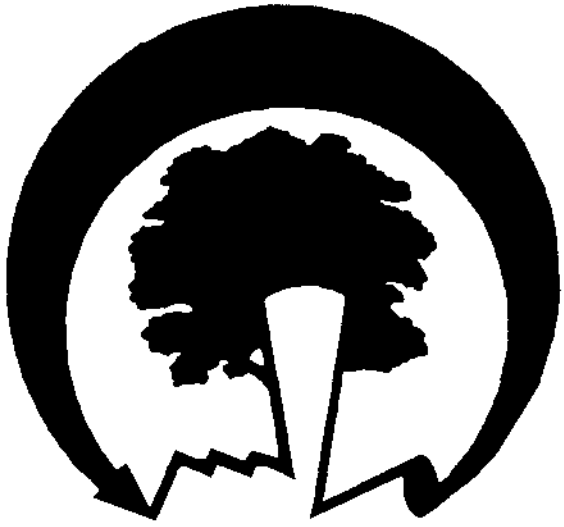
INTEGRATION OF WATER QUALITY PROTECTION AND LAND USE PLANNING IN DENMARK

AN ANALYSIS OF NITRATE CONTAMINATION FROM POLICY IMPLEMENTATION FAILURE.

GRETCHEN WOOD ROORBACH



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FORWARD

This treatise is the cumulation of a sixteen month study of the Danish land use planning and environmental policy implementation processes. Denmark has an innovative decentralized physical planning process which is simultaneously the administrative foundation for national environmental, economic and social policies. As discussed throughout this report, this unique physical planning and policy implementation process is a result of the country's social welfare form of government and its roots. Despite this unique policy implementation process's tremendous success in attaining national goals, promoting social welfare policies, and controlling environmental impacts from 1,000's of different industries; it has failed to adequately confront nitrate leaching from fertilizer applications. This report examines the political obstacles which have prohibited measures for regulating fertilizer applications and have as a result made Denmark the second worst nitrate polluted country in the world. It should also be noted that this report is not conclusive and only highlights the need for political and land use reform in Denmark to adequately address nitrate leaching. The authors ongoing Ph.D. research will offer substantial insights and definitive land use and political reform testimony.

General Situation

Denmark currently has a unique position politically, socially, and environmentally, since it is a Scandinavian welfare state, member of the European Union (EU), and is the second worst nitrate-polluted country in the world. The most influential factors in bringing Denmark to its present position are: geography and geological

conditions; 18th century land reforms; adult education programs in the middle of the 19th century; and, technological advances at the turn of the century. Danish political structures and environmental conditions were altered as a result of these land reforms.

Land Use Planning

Denmark's unique land use planning process incorporates national environmental policy. The country has a long history of land use planning. Present land use designation for agriculture, forestry, and urban areas have their roots in 15th century land protection policies[1].

The prevailing concept is for the planning process to be developed at the neighborhood level while reflecting national goals and policies. Through the physical planning approach triad which includes national, regional, and municipal levels, policies and goals are defined on the national level but executed with strong public participation at the local and regional levels. The theory is that the local public participation is more capable of reflecting local needs and conditions e.g economic, environmental, and social than national policy directives.

Policy Implementation

Danish laws are written as frameworks and not as directives. This allows implementation of national policies at the local and regional level to be flexible. Furthermore, it enables the regional and local agencies to interpret policies, laws and regulations to best reflect goals within their jurisdiction.

Policy implementation actually occurs through the twelve year regional and municipal master plans which are reviewed and updated every four years through a strong public participation process. This process also allows special interests groups to negotiate at the national committee level, and gives them the ability to place undue pressure on local and regional politicians and agencies. This part of the treatise examines both the economic and political forces, which have hindered the implementation of the national water policy.

Environmental Conditions

Nutrient poor soil conditions in Denmark, have resulted in a long legacy of environmental problems related to land use[a]. Changes in the natural environment created an early awareness of the interrelationship between land use and the environment. Today, Denmark's principal environmental concern is the impact of nutrient emissions (e.g. nitrogen and phosphorus), on the hydrosphere. These emissions are the result of agricultural processes.

Existing Danish water quality conditions are a direct result of its agriculture land use dominance (66%), soil structure, and ineffective water policy implementation. As previously stated, Denmark is the second worst nitrate polluted country in the world. It is therefore, not surprising that water quality control, clean up, and protection is a priority in Denmark. For the last several decades Denmark has been aware of increasing groundwater and surface water eutrophication resulting from agricultural fertilization practices. In the national report to UNECD 1992 Denmark stated "that the aquatic environment in Denmark is under immediate threat from the discharge of nitrates and phosphates from agriculture, industry and household sewage, and the discharge of pesticides, sulphate organic solvents and other substances besides the effects of years of spillage on the soil, industrial tipping and dumping of domestic waste on the land"[2].

Report Format

This report is divided into three distinct sections. Although each part is autonomous, each part also develops from the proceeding part. Part I: General Danish Conditions, offers a brief overview of how the

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[a]Denmark environmentally has a rich history. The landscape of Denmark was changed in the Iron age (500 BC - 750 AD) when large scale cutting of the deciduous forests began to make way for agrarian cultivation. Even at this point in history, the impacts were evident in the widespread growth of heaths began in cleared land on the poorer soils of west and central Jutland. Clearing the natural forests continued at such a rate that drifting sand became a major environmental concern and in 1680 the government attempted to save the remaining forests by enacting a law for reforestation and forest resource protection. Forestry protection was not to be enacted until the next century (1720) when the government initiated the first serious attempt to stop the drifting of sand by planting lyme grass and trees in northern Zealand.

Danish water quality situation evolved to its present condition, through an examination of social influences, economic considerations and governmental policies and their effect on land use development. The second section; Part II: Århus Case Study, analyzes the actual environmental policy implementation process through the regional planning process. The Århus case study focuses on two water quality protection projects in Denmark and their impacts on physical planning decisions. In addition, this study highlights short-comings of the existing environmental policy implementation systems. The final section of this report, Part III: Danish Environmental Policy Conclusions, analyses the unique Danish environmental policy implementation process and its implications for other physical planning systems.

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PART I: GENERAL DANISH CONDITIONS

Denmark has a complex interrelated environmental and land use planning process. In general, the land use planning process is the tool used for implementing national environmental policies. Since, Danish water protection policy is implemented through the physical land use planning process a thorough understanding of these factors is needed to assess, implement or alter water protection policies. This system was developed to allow land use planning and environmental policy implementation to reflect local geographic, socio-economic, and political conditions. These same factors however: socio-economic, political, and the geographical environment, are prohibiting implementation of national water policy.

In principle, the aim of the Danish water protection policy is to maintain all waters, e.g. surface, ground, and coastal, within Danish and European Community (EU) regulations free from additional treatment. The water policy is implemented through regional and local councils who are responsible for setting discharge regulations and designing appropriate land use zones which should reflect water protection policies. This policy implementation procedure has been extremely effective in controlling point-sources of pollution. However, due to the complex interaction of socio-economic, political and geographical factors this procedure is unable to control non-point sources. As a result, the national water policy goals have not been met.

The failure of water policy implementation is a result of historical land uses, economics, and political power. An understanding of the complexities of current water quality conditions and associated

regulatory implementation systems requires a review of historical factors. Socio-economic and political influences which arose during the second half of the 19th century not only reshaped Danish land use and environmental policies, but continue to exert pressure and influence on present day policies. Furthermore, reverse of the present trend towards degradation will require attention given not only to technical solutions, economic impacts, political consideration, but to the historical influences which have led to the current situation as well.

SECTION 1: HISTORICAL GEOGRAPHIC - LAND USE FACTORS

Physical planning in Denmark has been relatively straight forward throughout the country's history. The landscape has developed as a result of economic, political, and social factors over the last 900 years. Historically Danish land use planning has reflected its soil conditions (protection of prime agriculture lands and the designation of lands for forestry) and its geographic location (establishment of urban areas adjacent to trade routes). Current land use planning decisions and policies continue to protect prime agriculture lands, establish forest areas and protect economic interests. However, current land use planning policy processes also reflect the social welfare state form of government which requires a democratic process based on a strong consensus developed through negotiation.

Historical developments which gave the peasants access to land ownership and to education resulted in the emergence of an organized, politically strong, middle class of farmers. The economic importance of this new social class was demonstrated at the turn of the century when the farmers reacted quickly and efficiently to changing agricultural export needs. They were the instrumental force which shifted Denmark from a grain exporter to a dairy exporter in a ten year period. The current political and environmental conditions still reflect the interests of this strong farming middle class.

Agrarian Reforms

Radical agrarian reforms including the emancipation of the peasantry (1788); the abolition of the manorial system of cultivating common fields (1781); the development of individual lots available to peasants (which moved farms and farmers out of the villages) (1794); and, the consolidation of copyhold strips around one farmhouse. These reforms reshaped Danish landform and subsequently land management[3].

As a result, land which had not previously been cultivated due its to

distance from the village and/or environmental conditions (wetlands), were now consolidated and cultivated. Forests were cleared and wetlands drained to meet the land needs of the growing middle class farmer. This process was further accelerated by the Schlesvig-Holstein war in 1864 where Denmark lost the southern region of Jutland to Prussia and initiated a national campaign based on the motto "What is outwardly lost must be inwardly won". Reclamation of heathbeds, drainage of lakes and streams, and clearing of forests increased the agricultural area by 33% (1,729,000 acres) and created approximately 25,000 new peasant farms.

Educational Reforms

The establishment of "Folk High Schools" for adult education in 1840 started the education of peasants in 'the living word and the role of life'[b]. The schools encouraged education and self-education and introduced the peasants to history, literature, philosophy, and a civic outlook. The students created lecture and debating clubs as well as other associations and acquired experience in the democratic process[c]. The peasants simultaneously received full voting rights in 1849 and were thereby recognized as full members of the community. As a result of the democratic training they received in the Folk High schools, the farmers created their own political party, Venstre (conservative by American standards), which won its first majority in the government in 1901.

Co-operative societies which were established for optimal utilization

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[b]N.F.S. Grundtvig started the educational reforms and attacked the old grammar schools as being focused on the learning of irrelevant material by memorization. He created voluntary schools for young people who would live in groups with teachers for several months and learn practical applicable knowledge.

[c]Politically and socially Denmark has a long history as a democratically oriented society. In 1241 the Jutland Law was passed which recognized individual rights; King Hans (1481-1513) established a form of social security for the peasants. In 1683 Christian V extended the Jutland Law to Danish Law' which applied to the entire country. In the 1720's Frederick IV built 240 schools for boys and girls throughout the country to expand peasant education.

of the recently invented centrifugal cream separator were a reflection of the new democratic idealism. These societies revolutionized Danish agricultural production from a grain based to dairy and meat based production and simultaneously shifted the entire socio-economic conditions of the country.

Summary

At the turn of this century a new Denmark emerged. A Denmark in which a strong farming culture was governing the nation; an educated middle class; and, a strong democratic society. These factors laid the foundations for what was to later become the social welfare form of government.

The draining of wetlands for additional pastures and changes in agricultural production at the end of the 18th century, ensconced the agriculture sector perception of optimal exploitation of the land for production.

These two seemingly different factors at the turn of the century were to have far-reaching impact on the future of Denmark. The political, economic, and social welfare systems which are the direct result of this period, created intensive agricultural methods at a tremendous environmental cost.

SECTION 2: GEOGRAPHY / LAND USE PATTERNS

Present environmental problems in Denmark are a result of underlying geological conditions in combination with man made impacts. The geographic situation has influenced land use which has also contributed to overall environmental problems. The underlying soil structure has directly influenced the existing land use e.g. cultivated fields, woods, heaths, and dunes. For example the heaths began spreading over the poorer soils in western and central Jutland as a direct result of forest clearing for agriculture which started in the Iron Age (c. 500 B.C. - 750 A.D.)[4].

2.1 General Geography

Denmark proper is a small, (16,632 sq. miles), archipelago at the entrance of the Baltic sea and includes the low lying Jutland peninsula[4]. The Danish landscape is a result of the last glaciation in Europe in the Quaternary Period. Denmark borders the coniferous belt but its natural vegetation is deciduous forest (oak, elm, beech, and linden). Other natural plants include dune vegetation and heather. Land uses include cultivated fields, orchards etc. (66%); urban areas (12%); woodlands (12%); and heath, bogs or lakes, moors, dunes etc. (10%).

Population

The population in Denmark is 5.13 million with approximately 80% of the population living in the urban areas (1.3 million living in Copenhagen). The population distribution between rural and urban areas has not changed for centuries[5]. Development has always favored numerous small urban centers with sparsely populated rural areas. The population density is 308 persons/sq. mile.

Temperature

Denmark is in the temperate zone with an average winter temperature

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[4]This paper does not include analyses of Greenland and/or the Faeroe Islands unless otherwise stated.

is 20-40° F (mean 32° F in February). The summer temperature averages 50-70° F (mean 61° F). The climate is moist with a mean annual precipitation of 25 inches. The greatest precipitation rate, approximately 32 inches, is found in southwest Jutland. The temperate climate favors agriculture which has been the dominant land use in the country since the 11th century.

Geologic conditions

Geographically Denmark is characterized by glacial land forms from the most recent ice age. Sandy soils, old moraines, and outwash plains are predominant in western Jutland. Eastern Jutland and the islands are dominated by ground moraines (end moraines) and fertile clay soils (see Figure 1). In addition, the south-western part of Jutland contains the northern part of a continuous marsh area encompassing sections of Germany and the Nederlands. Along the south and north Jutland coast there is a perceptible tidal range with numerous salt marshes. Exposed bedrock is located only on the island of Bornholm but areas with original sea beds which has been raised since the last ice age are located in northern Jutland. Semonian chalk deposits are exposed at the base of cliffs in southeast Zealand were younger Danian limestone is quarried extensively.

Aquatic Environment

Denmark has an incredibly long coast line as a result of its numerous islands - over 45,300 miles (7,300 kilometers) and approximately 15,800 acres (64,00 ha) lakes and streams (not including wetland areas). Geological conditions, in combination with precipitation rates provide ample water supplies in west Jutland but do not favor the greater Copenhagen area where numerous streams and lakes dry up in the summer months.

2.2 Land use patterns

As previously stated, Danish soils and climate have influenced land development for centuries. Present day Denmark is typical of other western countries with urban sprawl occurring in the postwar period.

Figure 1. Denmark Surface Geology[6]

Fig. 2. Denmark, surface geology
1 = moraine, mainly clay; 2 = moraine, mainly sand; 3 = outwash plain; 4 = litorina deposits; 5 = yoldia deposits; 6 = hill islands; 7 = dunes; 8 = marsh. The unbroken line represents the limit of the main advance of the ice during the last glacial period (Würm)

In general urban areas and infrastructure have expanded while farmland has decreased as a result of urbanization or conversion to woodland. Table 1 is a breakdown of land uses in Denmark over the last 20 years.

Table 1.
Land use 1965, 1978 and 1982 in 1,000 hectares and change in percent 1965-1982.

	1965	%	1978	%	1982	%	1965-1982
Urban areas over 200 inhabitans	105	2,4	175	4,0	189	4.4	80,0
Summer cottage areas	24	0,6	41	1.0	42	1.0	75,0
Traffic areas outside urban areas	68	1,6	81	1,9	83	1,9	22,1
Scattered development in rural areas	84	2,0	123	2,9	132	3.1	57,1
Farm buildings, yards	108	2,5	94	2.2	89	2,1	-17,6
Hedgerows, ditches. lanes etc.	137	3,2	88	2.0	113	2.6	-17,5
Cultivated fields, market gardens and orchards	2693	62,5	2655	61,6	2651	61.5	-1,6
Woodland and plantations, incl. agroforestry	472	11,0	497	11,5	501	11,6	6,1
Meadows, Marsh, etc.	325	7,5	268	6,2	246	5,7	-24,3
Moors, dunes, bogs	223	5,2	223	5,2	198	4,6	-11,2
Lakes and steams	68	1,6	64	1,5	64	1.5	0,6
Total area	4307	100	4309	100	4308	100	

Source: Statistisk årbog 1990 (Statistical Yearbook 1990).

Land use variations within Denmark which are the result of geographic and geologic conditions can be understood when cultivated areas are examined. The tightest concentrations of cultivated lands are in south

Jutland County (72%) and Strorstrøm county (71%) which contain the countries richest soils. Whereas, the metropolitan region has the least (16.8%) and the urban Frederiksberg County the second lowest (43.2%).

Geographic Factors

Historic land use patterns and developments in Denmark have been strongly influenced by the country's geographical conditions. "The soil, the climate, and a position favorable to trading operations have shaped the basic conditions governing the country's economic development"[7]. Agriculture, from the earliest times focused on the nutrient rich soils of eastern Jutland, Fyn, and Zealand where the cultivation conditions were most favorable. The western Jutland area which is dominated by sandy soils has been historically the primary fishing area for the North Sea.

Social/Economic Factors

The strategic location of Denmark on northern trading routes and its regional geography have also influenced historic land use development. Copenhagen and Aalborg among other cities were strategically located in areas of heavy historical trade. These population centers not only supported the surrounding agriculture and fishing industries they also provided a strong network of defenses. In addition, Helsingør was developed for the sole purpose of levying high taxes upon ships sailing through the Baltic Sea.

2.3 Nitrate Impacts to the Hydrosphere

The Danish aquatic environment has been severely impacted in the last several decades as a result of the increase in nutrients from agriculture, waste water and energy production. Impacts associated with nutrient loading are the deterioration of groundwater quality and algae growth in freshwater streams, lakes and the marine environment. This has led to extensive eutrophication and high fish mortality levels[8].

Nitrate Sources

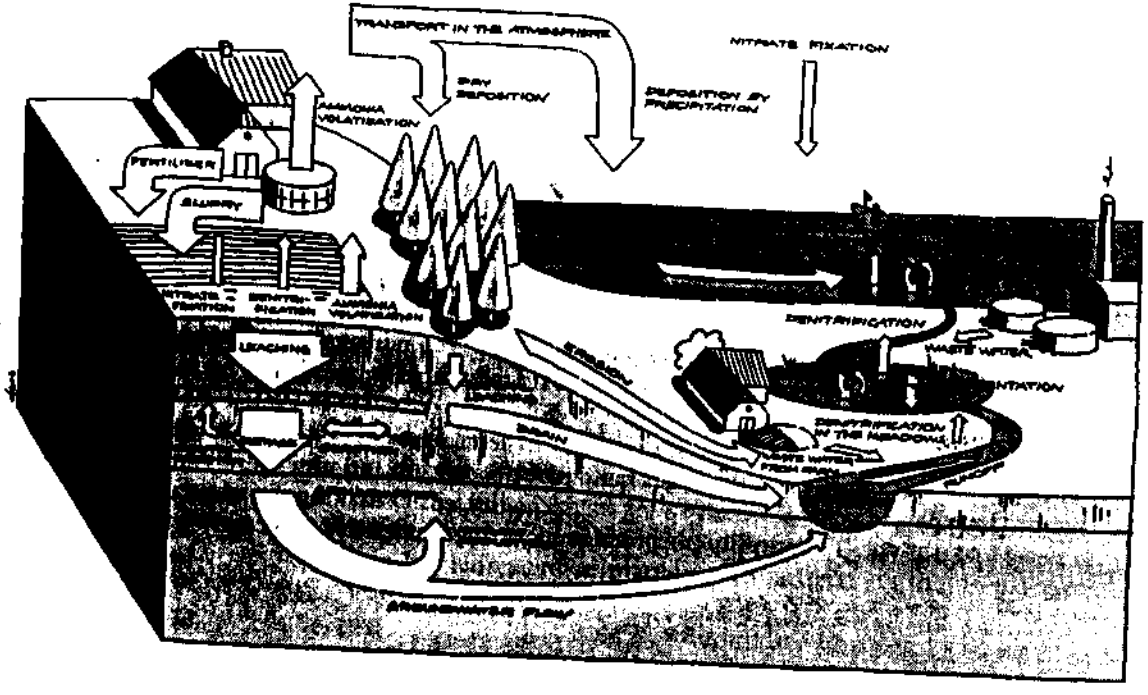
Nitrates are an important element for plant yields when other nutrients are plentiful in the soil. However, applications of nitrates in fertilizers at rates greater than the plant can absorb will lead to nitrate leaching into the soil-water into the groundwater and/or runoff the fields into streams, lakes, and rivers. It is therefore, to control nitrate leaching it is essential to stop over-fertilization.

The main source of nitrogen emissions into the Danish aquatic environment are the fertilizers used in agriculture production. Whereas, the main phosphorus emission is from domestic treatment plants. Other sources include fish farms and combustion of fossil fuels[9].

Nitrogen leaching from fertilizer applications is dependant upon numerous factors such as: soil pH, soil temperature, type of application (e.g. solid cattle manure, urine, cattle slurry, pig slurry, chemical fertilizers), soil type (clay, sand, etc.), seasonal application, and climate[10]. Figure 2 depicts the nitrogen cycle and its routes to the aquatic environment. Furthermore, numerous factors will affect a crops capability to absorb and utilize nitrate. Soil moisture, soil pH, soil type, iron and manganese content of the soil, precipitation rates, temperature, and type of nitrate application will all affect a crops ability to absorb nitrate and the soils ability to convert it to a non-harmful chemical.

The 1987 Action Plan on Sustainable Development in Agriculture developed specific recommendations to decrease nitrogen leaching related to these factors. For instance, in attempt to control seasonal impacts associated with runoff liquid manure may not be spread between autumn and March 1st.

Figure 2. The Nitrogen Cycle[11]



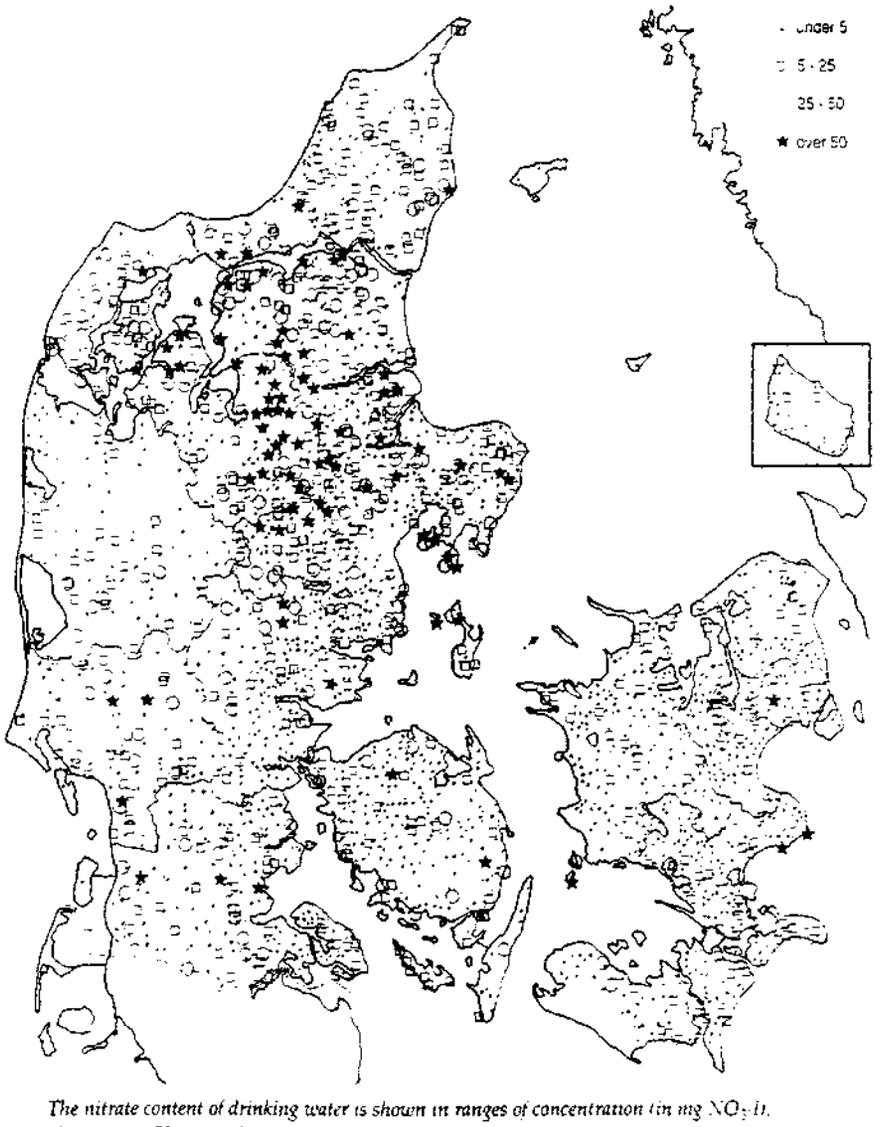
Groundwater

Approximately 489 mgd (1.85 mill. m^3) is available in ground-water resources. Groundwater is almost the sole source of drinking water in Denmark. Health impacts associated with the intake of large amounts of nitrates include infant methaemoglobinanemia (reduction of the body's ability to fix oxygen), stomach cancer and certain teratogenicities. An international limit of 25 mg of nitrate per liter has been established in Denmark with a maximum permitted content of 50 mg per liter[12]. Figure 3 shows the nitrate contents of drinking water in relation to these established levels. The highest nitrate levels are found in north Jutland. However, high concentrations are found sporadically throughout the country.

Numerous studies have been conducted to determine the amount of nitrate different plant require in different soil conditions to produce optimal yields at an economic optimum (cost of fertilizers verses profits). Sandy soils which are nutrient deficient and have a high soil water movement rate require larger nitrate applications in comparison to clayey soils. But as previously stated the over-fertilization of sandy soils will not increase plant yields but will instead increase the loss of nitrates to the environment. Nitrate leaching in Denmark is highest in sandy soils and impacts to sandy soils are clearly depicted in the nitrate levels in groundwater in areas of high sandy soil content[13].

Likewise, clayey soils also have a strong correlation between plant yield, fertilizer applications and nitrate leaching. Although, nitrate leaching occurs at a lower rate compared to sandy soils, clayey soils still present a problem as a result of over-use. Clayey soils contain more nutrients than sandy soils. Thus, historically these areas have been more intensively cultivated. Not only is over fertilization a problem in these areas but soil compaction from over use causes wide-spread surface runoff. Consequently, high levels of nitrate are also found in areas dominated by clayey soils.

Figure 3. Nitrate Content in Drinking Water Wells[14]



The nitrate content of drinking water is shown in ranges of concentration (in mg NO_3/l, cf. notation. The map shows the latest values for the period 1986-1990.

Source: Status for grundvand og drikkevand i Danmark 1990, Danmarks Geologiske Undersøgelse (Condition of groundwater and drinking water in Denmark 1990, Danish Geological Survey).

Watercourses

Danish watercourses have a total length of 40,365 miles (65,000 km). The input of organic compounds and nutrients in the form of phosphorous and nitrogen is a primary concern. Nutrients affects the composition and production of algae which in turn leads to eutrophication. Eutrophication is a process of oxygen depletion in water which alters/deteriorates the condition of the fauna and flora in streams. In 1989 about one third of the Danish streams failed to satisfy environmental requirements and the water quality of another one third was labelled critical. An estimate of 110,000 tones of nitrogen and 4,000 tons of phosphate are transported through streams to lakes and the sea in a "normal" year.

Lakes

Denmark has over 468 lakes exceeding 12 acres (5ha). However, the typical Danish lake is characteristically small - 20 acre average (1.1 km^2), shallow and have a short deposit time of water. In addition the average catchment area is 97km. Shallow lakes, are particularly vulnerable to increases in nutrients inputs. A direct correlation between phosphorous concentrations and the biological systems of lakes has been established. An increasing phosphorous level will produce more planktonic algae which will reduce transparency, the amount of bottom growing species, and the number of fish species[15].

In 1989 the average phosphorous concentration in Danish lakes was 0.3 mg per liter. Studies have determined that phosphorus concentration in eutrofied shallow lakes must be brought below 0.08-0.15 mg per liter or else significant changes will occur in their biological systems[16].

Marine Areas

Danish marine waters comprise three general categories with internal waters being a transitional area between the Brackish water in the Baltic Sea and the salty waters of the North Sea and Skagerrak. Danish marine waters have been severely affected within the last decade by a substantial decrease in oxygen concentrations and the decline of bottom living fauna. Furthermore, the populations of cod,

plaice (flatfish) and Norway lobster is declining[17].

2.4 Summary

Denmark's primary land use - agriculture has created a unique single environmental problem; nitrate loading of water resources results from fertilizer applications. By comparison, other industrial western states have a myriad of environmental contamination sources, impacts, and environmental issues. That is not to say other industrialized countries do not have nitrate leaching; the Nederlands, Germany, United Kingdom, and the USA, all have similar problems, but other more toxic life threatening overshadow nitrate leaching. What is unique about Denmark is the absence of large scale impacts from industrial wastes which therefore highlights the high rates of eutrophication and groundwater nitrate levels.

The soils in Denmark - clay, sand, and chalk - facilitate the development of relatively "clean" industrial practices (cement manufacturing), and prevented Denmark from developing a large industrial economy (based upon coal, steel, and iron) like some other western industrialized states. In addition, the precipitation rate, temperature, and type of soils support agricultural development with soil additives. As a result of these nutrient poor soils and present day intensive agriculture production methods dependency on heavy doses of fertilizer the aquatic environment has been severely impacted.

SECTION 3: SOCIAL-ECONOMIC FACTORS

Improving water quality trends in Denmark will require an analysis of social and economic patterns. Denmark has a long history of farming which is integrated throughout the culture. Even though today (1993) only 5% of the population is employed in the agriculture sector and its exports account for approximately 10% of the GNP.

The development of the Danish welfare state is a result of numerous factors. The land reforms at the end of the 17th century, education opportunities for the peasantry, and economic changes at the turn of the 20th century laid the foundations for the welfare state. In general, "a conservative society and a serious shortage of capital ensured a relatively slow and peaceful adoption to the concepts of democracy, co-operation and secularization"[18] The Danish welfare state involves income redistribution, regional distribution of wealth, and democratic decision making at all levels of society. Welfare benefits are perceived as a right and not as a hand out to the "needy".

As a result of this welfare state, the economic and social factors are inseparable. Approximately 72% of the labor force is a member of a labor organization. Furthermore, all of the farmers are associated with farmer co-operatives and societies which involve a system of sharing production activities.

3.1 General Economics

Denmark is characterized by high-tech agriculture, modern small-scale and corporate industries, (e.g. Lego); extensive welfare measures; comfortable living standards; and,a high dependency on foreign trade. Services account for 51% of the employment population; industry for 34%; government for 8%; and agriculture and fisheries for 7%[19].

The Danish economy has focused on the agriculture sector for centuries. Not only on agricultural exports but on industrial needs of this dominate sector. Manufacturing of tractors, seed sowing

machinery, corn harvesters, and dairy production machines are just a few examples of industrial agriculture manufacturing. What is unique about the Danish economy is its reliance on raw material imports to either feed agriculture animals or be manufactured into Danish crops.

Agriculture

Until relatively recently (1961) the Danish economy was dominated by agricultural exports. For over 100 years Denmark had exported approximately two-thirds of its agricultural produce. Today agriculture accounts for only 10% of the GNP and 5% of the work force. Agricultural exports continue to dominate farming practices. Today, Denmark produces approximately enough produce for 15 million people (three times the countries population). Two-thirds is exported primarily to the United Kingdom and other (EU) countries.

There are approximately 78,000 farms with an average size of 21-35 ha. As previously stated 66% of Denmark is actively cultivated. This breaks down to: 55% for grain (barley being the most important being 63% of this portion), 10% for protein crops (rape, peas), 5% for sugar beets and seed, 2% potatoes, and the remaining 28% being divided between meat production and fruit orchards.

Three-quarters of the average farmer income is from meat production and the bulk of the plant production is for livestock. Dairy production is the primary Danish animal product but pig production is the single most important growth sector in agriculture. Intensive farming practices and increased mechanization has had a heavy impact on Danish ecosystems. Larger fields and high densities of animals is the current trend in Denmark. Although not within the scope of this paper, numerous studies have been conducted in relation to the environmental and landscape impacts of these trends.

Industrial/Manufacturing

Government policies of regional economic distribution resulted in the equal development of manufacturing industries. For example, the policies for wealth distribution are reflected in the state's grant

incentives (1958-1985) for manufacturing industries to locate in rural areas[6]. Furthermore, because new industries located in areas which were previously not industrially developed this resulted in a wide distribution of small scale manufacturing companies throughout the country. Many of the factories and workshops were founded in rural areas, most notably in western Jutland, where new textile, clothing and furniture factories (developed in the 1940's and 1950's) provided full and part time employment for farming families and enabled others to abandon farming completely. The success of these factories was dependant upon available infrastructure and transportation systems. As these remote areas modernized to meet industrial needs, so did the rural areas. However, since the down turn in the economy at the end of the 1980's, many of these factories have had to close.

Service

A large service sector and high levels of public spending as part of the GNP is characteristic of a Scandinavian country. Producer services, distributive and transportation services, social services, and personal services are grouped together in the service sector analysis. In 1987 approximately 76% of the Danish working force was in the service sector where 33% were public employees. Reflecting the Scandinavian policy of redistribution of wealth Denmark spent 57% of its GNP on public spending, Norway 53% and Sweden 80% in 1987.

3.2 Social Influences/Co-operative Societies

A substantial part of the present day Danish culture and political life originates from the peasant farmer community and the revolutionary changes this population experienced at the turn of the century. Two distinct types of co-operative societies emerged: the farmer co-operative societies and the labor unions. Although both societies agree on the efficiency of co-operative working arrangements, their

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[6]Government policies of rural industrial development were originally, in part, a response to the growing unemployment rate in the farming sector. As this rate leveled off the industrial development policies, in an attempt to attract new industries, shifted to the urban centers which offer better infrastructure, social services, and account over a third of the country's population.

approach and goals are distinctly different. Each has nonetheless had an impact on current welfare state policy. The farmer co-operatives are relatively conservative in political terms by American standards, and do not support strong state influences or the redistribution of wealth. The farmers support conservative capitalism ideology and a free market economy. This ideology is a hold-over from the sector's dominance in the dairy market at the turn of the century. Although a free market is no longer possible given Denmark's membership in the EU the farmers continue to voice strong opposition to any state controls or regulations in their sector.

On the other hands,the labor unions, with their emphasis on job protection, may be considered more liberal and far-sighted. Labor unions have been instrumental in developing new systems for job definitions and security.

Farmer Co-operative Societies

Co-operative agricultural societies in Denmark revolutionized Danish culture and society as a whole. "New concepts in spiritual life - in church, in schools, in literature - and in political thought was found fertile fields , developed, and came to inspire the rest of Danish society."[20]. Three major factors can be attributed to the development of these co-operatives: national democratic principles established through the Folk High Schools; establishment of a liberal government; and, economic factors in Europe at the turn of the century. "The co-operative societies altered the structure of agriculture as well as the villages as the peasants were transformed from being poor and unproductive farmers to being social and politically active, open-minded, and progressive[21].

Co-operative societies were not only a democratic response to the changing dairy market they were an economic necessity. Sharing of mechanical resources was the only way the recently acquired small peasant farms could survive. Harvesting equipment, seed sowing mechanisms and the centrifugal cream separator were prohibitly expensive to an individual farmer but were feasible if enough farmers

divided the expenses. Therefore, pooling of resources to share these mechanisms was not only an economic necessity but allowed the farmers to compete with larger farms which could afford the new technology. Furthermore, the cooperatives established strict quality controls which further enhanced the competitiveness of the small individual farmer. The co-operatives were democratic societies orientated to the betterment of small individual farmers. The basic principles and/or rules for the co-operative societies were "(1) profits should be divided among members according to their production or purchase, (2) the members elect their committee members on the principle of one man one vote regardless of the size of his production or purchase, and (3) membership should always be open to new members from the region covered by the association"[22].

Labor Unions

During the environmental awareness campaigns of the 1970's the Labor Unions became aware of and were influential in worker safety. Initially, their primary orientation was towards indoor (work place) hazards. Today, Labor Unions are starting to become advocates for a clean healthy outdoor environment in an effort to attract new businesses to Denmark. As the high-tech industry continues to expand once seemingly unimportant factors, in relation to labor, are now crucial for attracting expanding industries. For example, a highly educated work force, clean environment, good school system, and medical care are now important consideration for industries when siting new headquarters or manufacturing centers. Therefore, the Labor Union are on the new band-wagon of ensuring the "Denmark Towards the Year 2018" goal of Denmark having the best natural and social position in Europe. The labor unions understand that realization of this vision requires Denmark to have an extensive clean natural environment.

3.3 Summary

The historical dependency upon agricultural exports and the development of the farmer co-operatives have given the farming sector tremendous influence in policy development, despite its small

percentage of the workforce and GNP. Nevertheless, the agricultural sector is publicly perceived as being much larger and continues to have a decisive say in land use and environmental policy implementation.

Danish nitrate leaching is not only an environmental problem but is also a political issue. The lack of regulations and adoptions of firm laws to control nitrate leaching in large part due to political influence exerted by the agriculture industry. The increasing levels of nitrate in the Danish hydrosphere at a tremendous environmental and economic cost attest to this sectors political influence.

As a political outsider it is relatively easy to criticize the weak-kneed politicians and growing and economically stronger industries (e.g. tourism) for not having a more active role in setting environmental policies. However, this peripheral view does not take into account the political factors influencing policy development.

SECTION 4: POLITICAL FACTORS

Denmark is a constitutional monarchy and a parliamentary democracy. There are fifteen political parties which represent a wide spectrum of political opinions.[f] Unlike the American political system which polarizes public policies, Danish laws and policies are administer through a highly developed system of negotiations with consensus building and conflict resolution[23]. As a result, laws and policies are widely accepted by all political parties and the populace.

Social awareness of environmental problems in the 1960's, resulted in radical political reform in the 1970's. The ensuing decentralization process of physical planning was an attempt to create a more democratic process which would meet the environmental, social, and economic issues on the local, regional and national level. Before these reforms were enacted many municipalities were either completely urban or rural. The rural communities were characterized as having strong economic and social conservative biases which resulted in extremely underdeveloped (in terms of welfare benefits) areas, but with financially well-off farmers. To democratically develop the country the reforms divided into 14 counties (amt's) and 275 municipalities (kommunes).

As a result of the 1970 municipal reforms, local government is a hybrid of national, regional, and local interests. The governments' policy for flexibility and decentralization can be clearly seen in environmental and planning legislation where the counties' are responsible for implementing national environmental policies through the planning process. The open format of national legislation allows the counties' to interpret the goals and objectives of the acts and adopt them to local conditions while theoretically meeting national goals. However, this decentralized process has been exploited by special

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[f]Social Democratic, Liberal, Conservative, Radical Liberal, Socialist Peoples, Communist, Left Socialist, Center Democratic, Christian Peoples, Justice, Progress Party, Socialist Workers Party, Communist Workers Party (KAP), Common Course, and Green Party.

negotiation process and local implementation through the public participation process.

4.1 Environmental Policies

Although there are many laws and acts which relate to water quality the primary legislation which regulate water extraction and water supply are the Environmental Protection Act (Part 3) and the Water Supply Act.

The Environmental Protection Act

In its first line, the Environmental Protection Act states: "the purpose of the Act is to contribute to safeguarding nature and environment in Denmark, thus ensuing a sustainable social development in respect of human conditions of life and for the protection of flora and fauna"[24]. The Act essentially permits requirement for all emissions to the natural environment (air, water, soil, etc.) that may have adverse impacts, and thus is similar to NPDES requirements in the American Clean Water Act. The objective of the Act is to manage polluting emissions, control and/or solve local problems of pollution recipients, and to permit pollution at certain levels in recipients. Emission levels and thresholds are therefore dependant upon the carrying capacity of the recipient which allows regional areas to compete for industries and meet another important object of the act, namely to promote regional industrial development. Since the act regulates the pollution in the recipient, in some sectors, and not at the pipe, regional councils have used emission standards as a method to attract industries from urban areas which usually have stricter emission standards as a result of already polluted recipients. However, as national standards have become stricter, regional "business sense" has shifted, and the councils have realized that a clean environment is much more attractive to new industries than emission standards. Although the "dilution is the answer to pollution" mentality still exists in some communities the tendency is towards stricter national threshold and standards. Furthermore, the development of water quality plans has shifted regional and local emission policies.

The permitting requirements in the Environmental Protection Act are the responsibility of local and regional councils. Monitoring criteria (if any) are also determined by the local and regional councils. Furthermore, enforcement is also the local and regional council responsibility. Although this decentralized procedure allows for flexibility in negotiations with industries the local and regional councils do not always have the economic and manpower resources to monitor and enforce provisions of the permits. Recent trends towards tighter national thresholds and emission standards are a welcome relief to regional councils. Although, many elements of the act, e.g. enforcement, could be more effective at the national level where local political repercussions are not so onerous.

In addition, the Environmental Protection Act is strictly orientated towards point sources of pollution. Despite enforcement shortcomings the Act has been successful in regulating industries and waste water treatment plants. Yet, the Act is not structured to regulate the more menacing non-point sources, such as nitrate leaching. Legislation and regulations addressing non-point sources is needed to control nitrate leaching. For example, nitrate leaching models for individual fields based upon crops, fertilizer applications, soil etc. could be developed into a non-point "leaching" tax.

Water Supply Act

The objectives of the Water Supply Act are to ensure:

> "1) that the use of water resources takes place according to integrated planning and through comprehensive evaluation of the considerations mentioned in section 2 [size of water resources; needs of the population and industry; environmental protection; protection of raw resources],
>
> 2) Co-ordination of existing water supplies with a view to an appropriate use of water resources,
>
> 3) planned extension and operation of a water supply

that is adequate with regards to volume and quality"[25].

The Water Supply Act is similar to the Massachusetts Water Resources Management Act, but as in the Danish Environmental Protection Act, the development of criteria is left to the counties/regional councils. The regional councils are responsible for the implementation of this act and for protection and preservation of water resources. Similar to the Environmental Protection Act this law does not account for widespread fertilize applications. For example, an amendment to this law establishment protection zone and land use regulations (e.g. no fertilizer applications) would assist the regional planners meet the laws goals for protecting water supplies.

4.2 Physical Planning Policies

In the early 1970's, Denmark embarked on one of the most ambitious reforms of national and local government in postwar Europe. While restructuring the municipalities and counties, this reform simultaneously converted a centralized bureaucracy into a decentralized regional and local planning and policy implementation system. Most notably, this planning reform shifted national decision-making powers to local governments in the areas of town planning, environmental control, education, and health.

The 1970's planning reforms established a three-tier approach to land use planning: national, regional, and municipal. The intention of the planning reforms was "to simplify and modernize the planning legislation and to establish a coherent planning system, ensuring that planning considerations were made on the basis of overall considerations of impacts on society and that the national, regional, and local level was coordinated"[26]. The actual implementation of national, regional and municipal planning occurs "through a flexible process where the law is used as a guideline and not as a directive"[27]. In addition, Denmark has shifted its planning process towards an increasingly public oriented democratic process. The aim is for

planning processes to be developed upwards from the neighborhood level.

These reforms theoretically created a physical planning process which develops on the local level and reflects regional and national goals. In addition, physical planning occurs through a collaboration of many people in different fields so that the resulting plan will reflect all community needs (e.g sociology, landscape architects, architects, engineers, biologists, etc.)
The twelve year Regional Plans developed by the counties' and reviewed every four years is the Danish tool for environmental policy implementation and protection. Environmental impact statements, zoning, agricultural interests, afforestation interests, and protection of nature reserves are required in the supporting legislation.

However, despite this holistic approach the physical planning processes in Denmark have been unable to prevent the deterioration of water quality.

Regional Plans

The 1992 Planning Act and the previous National and Regional Planning Act require each county to have a regional plan which will cover a 12 year period and be updated every four years. The regional plans designate zones for summer cottages, urban zones, afforestation areas, agriculture areas, and nature preserves.

The regional plans are the Danish environmental protection tool and must include guidelines for: the use and protection of water; the location of businesses that require special siting to prevent pollution; the location for major developments; the designations of valuable agricultural lands; and the designation of areas with mining interests[28]. Furthermore, the counties must establish guidelines and criteria for environmental impact assessment of major development projects.

The key word in regional plans is "guidelines". Regional plans are not legally binding (except for zone categories) and a landowner can

disregard the regional plan and not receive any penalty. The counties have a limited number of land use designations e.g. urban, summer cottage, rural in which to protect environmental resources. Designated areas-not zoned-for reforestation and nature preserve are for future land uses but do effect current practices. This situation is apparent in the number of counties that designate water resource areas "afforestation" to limit land use activities. The planning procedure is for municipal and local plans to adopt the goals and objectives of the regional plan. However, even though local plans are legally binding, they rarely extend to rural areas where natural resource protection is required. Therefore, a new process which can legally control land uses in the rural regions is required if natural resources are to be protected.

4.3 Summary

The general Danish water protection policy aims to protect all groundwater so that additional cleaner water sources or treatment will not be required within any region of the country. Furthermore, the Danish policy is to have all water supplies comply with Danish and EU quality regulations without the need for treatment.

Environmental policy in Denmark is developed behind close doors and is generally a negotiation process with various interest groups. Although, this process has been extremely successful in controlling point-sources of pollution i.e. industrial emissions and waste water discharges, it has not controlled the politically strong agriculture sectors impacts to the hydrosphere. This open format of the ensuing legislation not only allows flexibility of implementation but allows this behind-the-scenes negotiations to occur between the counties and industrial and agriculture organizations. Although this environmental policy development process may be quicker in the long run it can also give undue influence to certain interests groups (e.g. agriculture), and it restricts public participation.

The counties' are responsible for implementing environmental legislation through the granting of permits and environmental policy

through the physical planning process. However, the counties' do not always have the resources (economic and man-power) to enforce or monitor the permits and there are no appropriate laws to protect water supplies through the planning process. For instance, water Supply zones, aquifer overlay districts, and numerous other tools used in the USA for water quality protection are lacking in Denmark. Since water supplies in Denmark are being contaminated by nitrates in fertilizers, restrictions and best-management practices for fertilizer applications need to be developed and implemented on cultivated fields. However, the counties lack the appropriate tools to regulate fertilizer applications. The counties can negotiate with farmers through the regional plan procedures but they do not have the authority to prohibit or deter inappropriate land uses unless permitted under the Environmental Protection Act. This is a "catch 22" for planners since fertilizer runoff and leachate is a non-point pollution source and is thereby exempt from the Environmental Protection Act.

Amendments to the Environmental Protection Act and other laws and regulations which would grant the counties stronger water quality protection and enforcement capabilities must be adopted by the Danish Parliament (Folketing). However, as stated previously, the Danish political processes enables certain sectors e.g. agriculture, to place pressure upon legislators and staff to limit the scope of applicable laws and regulations.

Political aspects of water protection strategies have impacts on national, regional, and local governments. Any water protection strategy and nitrate reduction scheme will affect agricultural practices and Denmark has one of the a strongest agriculture lobbies in the world. Legislation and regulations which would have a strong impact on agricultural practices, and would be considered hostile to the agricultural sector and would therefor be political suicide.

Finally, many water protection strategies, for instance, land taking, fertilizer taxes, non-fertilizer zones will influence a politician's re-

electability at national, regional, and local levels. Unemployment rates, agricultural subsidies, agricultural lobbies, national character issues are other important issues which must be addressed with other technical and environmental problems in an integrated water protection strategy. This creates no incentives for politicians to encourage legislation which regulates agriculture if they want to be re-elected every four years.

SECTION 5: CONCLUSIONS

Regulations aimed at industry, municipalities, and agriculture have slowed the rate of water contamination but has as yet alleviated or diminished the threat to groundwater and surface water eutrophication. "Preliminary analyses show that while emissions by industry and municipalities have been reduced as planned, those by agriculture, which have fallen for nitrates by 20% in response to restrictive measures of the Plan [1988 Action Plan], cannot fall further to meet the plans aims"[29]. In addition, it is estimated that there is a twenty year reserve of nitrates in Danish soils. Therefor, even if all nitrate applications were ceased today, nitrate levels would not fall for at least twenty years.

Land Use - Environmental Planning

Land use planning has a long history in Denmark. Economic and geographic considerations initially directed land use development. For example, harbors were developed for trade and defence. As the impacts to the environment started to become visible, environmental planning techniques were incorporated into the planning process e.g. the establishment of forest areas to reverse the drifting sand trends. Yet, local economic factors have remain the most influential factor in the land use planning process. This tradition is reflected in the current flexibility of environmental policy implementation through the regional planning processes.

Environmental Problems

Denmark has primarily one environmental problem - nitrate loading to the aquatic environment. This is a unique situation when compared to other western industrial states which developed their economies and environmental problems through industrial exploitation of numerous raw materials. Nitrate loading in Denmark is a result of fertilizer used to enhance agriculture yields. Nitrate loading is widespread throughout the country because 61% of the land is currently cultivated.

Impacts on the aquatic environment from fertilizers have been carefully monitored and documented for the last several decades. However, as the government admits in the UNECD report not enough is being done to reverse the nitrate impacts and the existing nitrates in the soil and water will be present for at least 20 years.

Environmental Policies

As in other western industrialized countries, environmental concerns did not dominate the political process until the late 1960's. However, unlike other countries Denmark has developed flexible environmental policies which are implemented through a decentralized process. Theoretically this process allows greater public input and is more sensitive to local conditions. Nevertheless, in practice this process weakens the goals of the national environmental policies and has created a severe aquatic environment stress. For instance, the Environmental Protection Act, which is based on dilution, has caused local and regional agencies to compete with each other by offering lower emission standards in order to attract industry.

The 1988 Agriculture and Water Action Plans adopted by the government and accepted by the agricultural community set lofty, unreachable goals to reduce nitrate emissions to acceptable levels. Notwithstanding, the Action Plans accomplishments (reduction of nitrates by 20%) emission levels are still too high and impacts are still to great to reverse the degradation effects of nitrate loading. What is most disturbing is that even close co-operation between the agriculture community and the government to address nitrate impacts are not effective enough. It seems that a completely new farming structure in Denmark will be required to adequately reverse the impacts associated with nitrate loading.

The Danish national water policy aim is to preserve existing quality without the need for additional treatment. Water
supplies are to be protected and preserved so that other cleaner sources are not required. This policy is reflected in local regional plans. However, local politics and economic considerations often

hamper the regional councils ability to implement water protection policies adequately.

Water Policy Implementation Failure

Despite the rhetoric and stated national policy goals, the process of environmental implementation through the local physical planning process is not working. The primary culprit is the agricultural sector which influences national and local policy makers. Politicians at all levels of government are not willing to risk offending this group, and thereby lose votes. As a result, strong regulations and amendments to existing laws which would control fertilizer applications are only submitted to after a public outcry, as in the case of the 1987 Action Plan.

In addition, Danish geographical factors exacerbate the impacts of fertilizer applications. The clayey-sandy soil mixture, weather conditions, and land use distribution have all led to inappropriate levels of fertilizer use which applications results in high nitrate leaching levels. This problem is further exacerbated by the filling-in of wetlands, at the urn of the century, which removed natural nitrate filtration systems.

Finally, socio-economic factors contribute to water policy implementation problems. Regional and local councils are held accountable for balancing economic, social, and political factors in determining environmental protection strategies. Regional and local planners and politicians are responsible for attracting new businesses and hate to risk potentially negative impacts on the dominate traditional land use.

Hence, the national water protection policy is not achieving its objective.

PART II: ÅRHUS CASE STUDY

The County of Århus is facing severe potable water shortages as a result of nitrate contamination from agricultural practices. The following review of the County examines how the regional planning process assimilates national environmental goals with regional economic and sociological needs. However, as the Århus example illustrates, regional planners do not have adequate authority to manage land uses and therefor cannot meet their national water policy mandate. In addition, the geographic, socio-economic, and political factors, discussed in Part I, inhibit regional planners whose land use plans and regulations must be accepted by the regional council of elected officials and the general public.

Århus county, is currently developing and designing the 1997 regional plan which focuses on water quality protection. This case offers a unique insight into national water quality implementation processes. The county is conducting two independent studies to determine the most appropriate technique for national water quality implementation.

ÅRHUS COUNTY GEOGRAPHY / LAND USE PATTERNS

The County of Århus is located on the eastern coast of Jutland (see Figure 4), covers an area of approximately 456,000 ha, includes 26 municipalities, and has a population of 605,000 in 1993. Århus is considered the largest county in Denmark with an average density of 132 persons/100ha (compared to an average of 120 persons/100ha for the rest of Denmark).

The county of Århus also has typical Danish land use divisions:

14%	forested	(12% Denmark)
62%	cultivated	(66% Denmark)
10%	urban	(12% Denmark)
14%	other	(10% Denmark)

The county is primarily located on a young moraine with an outwash plain following the Gudenå river valley. The soils are predominately clayey-sandy and sandy-clayey. As a result of the dominate agricultural land use and soil types some of the highest groundwater nitrate levels in Denmark are present in the northern part of the county (see Figure 3 in Part I).

Figure 4: Location of the County of Århus

SECTION 1: 1997 ÅRHUS REGIONAL PLAN

Achieving national water quality standards and general water quality protection is the goal of the 1997 Århus 12 year regional plan[30]. The land use planning decisions reflected in the regional plan are not only based on water quality requirements but also other environmental, economic and social considerations. Thus, preserving cultural landmarks through open space designations and zoning industrial areas in order to attract new businesses are examples of two diverse issues reflected in the regional plan.

As discussed in Part I, regional planners are responsible for zoning land either: rural, urban, or summer-cottage. These three land use designations are then incorporated into the more detailed municipal and local plans. It should be noted, that these are the only land use zones legally binding in Denmark, although other designations, e.g. forests, may be shown on maps they are not legally binding.

1.1 Water Quality Protection Strategy

As reported in Part I: Section 4, the general Danish water protection policy is to protect all groundwater so that additional cleaner water sources or treatment will not be required within any region of the country. As also elaborated in Part I, non-point sources of nitrate leaching have yet to be managed or controlled. The County of Århus is no exception and groundwater nitrate levels in many wells in the northern portion of the county have exceeded national standards. In order to protect these supplies and preserve and protect other groundwater supplies, the county has developed a new protection strategy and policy.

The County of Århus' general water protection policy is to clean, preserve, and protect water without adversely impacting existing economic enterprises[31]. To meet this goal the county has developed a new strategy which incorporates international (EU), national, and local environmental requirements. Specifically, the Groundwater Department has developed a water protection zoning system which the

county is utilizing to direct future land use decisions and simultaneously satisfy EU set-aside requirements, national forestry and water policies, and local needs.

The county is using geologic maps and pumping rates to determine zones of influence. Each area is then categorize as priority 1, 2, or 3. Priority 1 recharge areas are those areas which currently have elevated nitrate concentrations, priority 2 areas are vulnerable to contamination; and, priority 3 areas have a high quality of water and should be protected and preserved. These priority classifications are then broken down into a zone system for physical planning implementation.

The groundwater resource zoning includes:

Zone 1, is a 10m radius from the wellhead. A fence is usually erected to deter any access to this area.

Zone 2, is a 300m 'hygienic zone' from the wellhead where any land uses that could negatively affect public health (e.g. waste water discharge, leaching fields, etc.) is prohibited.

Zone 3, includes areas that are deemed vulnerable within the entire recharge area. Specific industrial and agricultural restrictions are imposed within these areas.

Zone 4, is the recharge area (aquifer) based upon geological conditions. Regulations to be imposed within this area are not as restrictive as those implemented within zone 3, but aim at ensuring orientated towards water quality.

Zone 5, is the area covered by a flexible ban surrounding the recharge area and is considered a 'warning district'.

Zone 6, is the zone located outside the recharge area and area of groundwater interests. Heavy industry and other land uses considered "dirty" e.g. landfills, should theoretically be placed within this zone[32].

1.2 National Policies to be addressed in 1997 Regional Plan

The proposed 1997 regional plan focuses on areas for reforestation, open space/nature preserves, and groundwater protection. The plan is an attempt by the county to meet the numerous agricultural and environmental requirements and policies set by the European Union (EU) and the Danish government. The plan is being designed to combine these various policies and goals into a sound land use plan in conjunction with the ground water protection zoning strategy. These two programs are being interwoven in the 1997 Regional Land Use Plan.

EU set aside program

European Union environmental and agriculture subsidy programs are not new. Subsidies for environmentally sensitive areas (EIAs); set-asides; changes to fertilizer practices; and forestry designations are just a few of the many programs that have been viable to Danish farmers for years. But as repeatedly documented these subsidy programs have not offered enough financial incentives to farmers to stop existing practices[33]. However, the new set of subsidies which were developed as a result of the EU Common Agriculture Policy (CAP) reforms have a strong orientation towards environmental protection.

In general, the EU Common Agricultural Policy (CAP) was reformed in 1992 to reduce surplus production and meet other goals defined by the community. The reforms were designed to maintain the EU position as a major agricultural producer, to reduce the production surplus and bring production into line with market demands, to focus support on farmers incomes where it is most needed, to encourage farmers to remain on the land, to promote non-agricultural use of

farmland, and to protect the environment and develop the natural potential of rural areas partly through reforestation. The reforms established aid schemes and programs for: the protection of environmentally sensitive areas; reforestation; and early retirement of farmers. Although all of the 1992 CAP reforms have impacts on Danish agricultural policies, the set-aside requirements are the most important and relevant for the 1997 Århus Regional Plan.

The keystone of the CAP reform subsidies is the set-aside requirements. The EU Danish set-aside eligibility regulations require that 18% of each farmers non-rotational land with cereals, oil seeds, and legumes, be set-aside as fallow land for 20 years; and, that 15% of rotational land used for other crops be placed into fallow conditions for at least 5 years[g]. The EU set-aside reforms and programs are strictly on a volunteer basis. Farmers are not required to participate but are enticed through monetary subsidies. However, the subsidies, to date, have not adequately compensated Danish farmers, for lost revenues.

Danish national forestry policy

The Danish governments' forestry policy is to double the country's forested areas within the lifetime of a tree (approximately 70 years). This policy was established to not only optimize forest production, conserve and protect forests, improve stability and the structure of forest ownership, but to also protect landscape amenity, promote concern for cultural heritage, protect recreation opportunities, and facilitate nature conservation and environmental protection interests (e.g. critical watershed and aquifer areas). The government, in coordination with the counties, has developed a "general master plan" for forest areas for the entire country[34].

Designated forests areas are to be defined in the regional plans.

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[g]Denmark and the United Kingdom received a special condition for the set-aside requirement. The remaindered of the EU community has a 20% non-rotational set-aside (cereals, oil seeds, legumes), and a 15% for rotational crops.

are offered to land owners impacted by the new regulations. Each county is responsible for designating new forested areas. Århus county, which currently has 14% of its jurisdiction forested, and designated an additional 20,000 ha (4%) for new forests which will bring the total forested land to 18%.

The county is hoping to meet EU set-aside requirements and the Danish national forest policy in its 1997 plan. The designated reforestation, and open space/nature preservation areas were deemed inappropriate for agriculture or urban developments by the water zoning scheme and soil analysis.

Open space preservation areas have been designated as important areas for protecting natural and cultural features. Grasslands, wetlands, heaths, wildlife, and environmentally sensitive areas (ESAs) have been delineated as vital open space areas which are to be preserved. Furthermore, cultural features such as; burial mounds, significant views and view corridors, and special landscapes also have to be preserved.

1.3 Summary

The County of Århus is confronting water quality problems in their 1997 Regional Plan. To adequately preserve, protect, and clean up water supplies the county has designed a groundwater resource zoning strategy which will assist the county meet national and regional water policy goals. The water zoning strategy implementation combines land use planning (urban, rural, summer-cottages) and Danish and national subsidy programs. This approach is impressive because it is a holistic approach to land use planning.

A regional plan is only a guideline. Municipal and local plans flush-out the regional plan's goals and objectives through their land use designations. Notwithstanding, regional plans establish the development framework and account for the broader environmental issues of the region; whereas, municipal plans stop at their jurisdictional boundaries. The County of Århus's scheme of

designating sensitive natural resource areas (e.g. water quality sensitive and forests), is just the first step, and is not a legally binding step, to achieve natural resource protection. But these overlay land use designations are a start, and will initiate dialogue between land owners and the county in its attempt to protect natural resources and meet national and international directives.

SECTION 2: Tunø Example

The County of Århus pilot project on the island of Tunø is being conducted in response to a shortage of potable water which is a result of groundwater contamination from nitrates. The project consists of extending the water protection zone from 10m to 100m, monitoring ground water nitrate levels near a public water supply wellhead, and working with the farmer(s) in the wells zone of influence to implement 'best management practices'. The results of the enlarged water protection zone, purchased by the Odder Kommune has had a positive impact-decreased levels of nitrate-in the soil water.

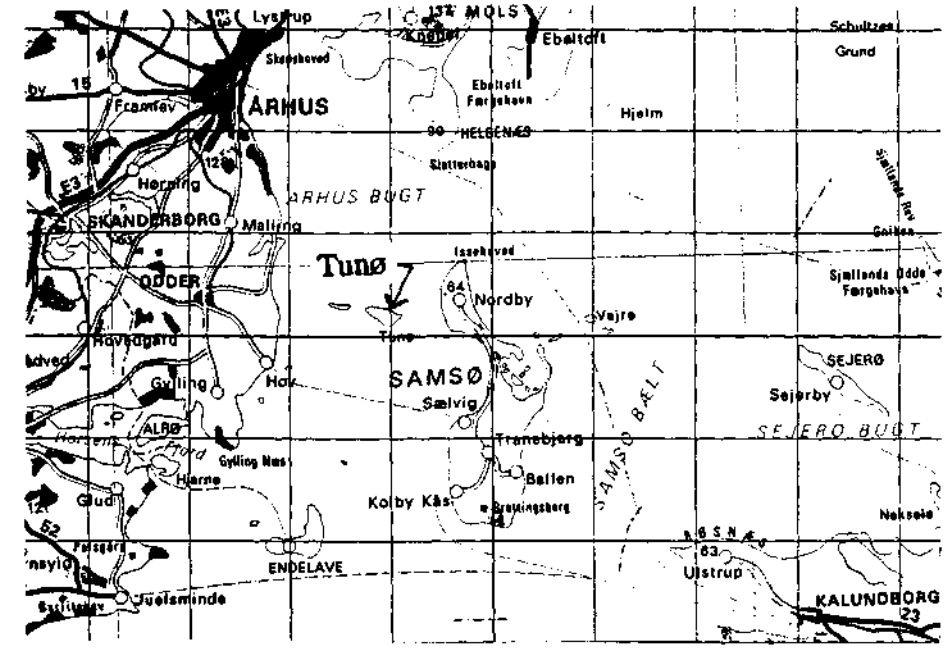
2.1 General Background

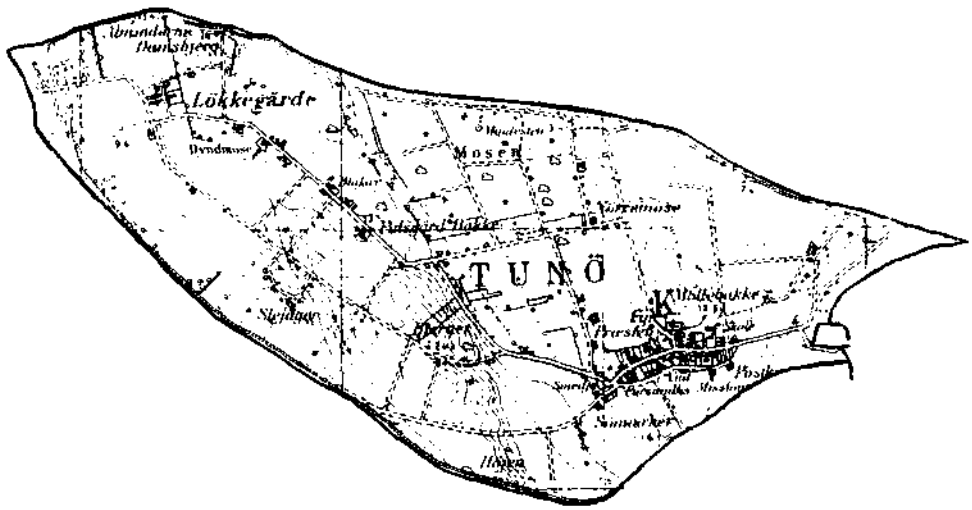
Tunø is a small island (4 km^2) located between Samsø and Jutland. The island is in the Odder Kommune and the County of Århus. Year round population is approximately 70 with a summer population of about 2,000. Two villages are located on the island, Tunø and Løkkegarde. Tunø, in the western part of the island, is the main town and includes the harbor. There are also many scattered farms on the island (see Figure 5).

In 1989 the Tunø project was launched in reaction to the increasing levels of nitrate in the B3 well and the concerns of potential salt water intrusion due to increased pumping and a decreased water table. Numerous solutions to reduce the nitrate concentrations were considered, e.g. installing ion exchange or reverse osmosis plants and importing drinking water via pipe or tanker. The establishment of a Water Protection Zone was determined to be the best and least costly solution.

To appease local politicians and determine scientifically if drinking water wells and agriculture can co-exist the Århus county initiated the water protection zone study around the local well which allowed existing agriculture to continue. "Best management practices" and appropriate fertilizer application implemented within a 300 meter zone from the well head, as well as the purchase by the municipality of 3

Figure 5 Tunø





ha within 100 meters of the well for permanent grassland have all had an effect. By 1990, three years after the project start, the soil water nitrate levels within the permanent grass area had declined although no change was observed in nitrate concentrations in the water supply well. In 1991 the water supply wells recharge zone was more precisely determined and the municipality of Odder initiated a land swap with the active farmer and purchased an additional 3.5 ha for grassland.

The Tunø project is a microcosm of the many diverse issues Danish planners and policy makers confront in reducing nitrate levels in water. This example demonstrates the need for a careful balance between environmental, economic, and sociological considerations. Economic considerations were the overall determinant in establishing and expanding water protection zones in combination with 'best management practices' instead of implementing other more costly alternatives. Economic factors included: land costs, equipment costs, and loss of production costs balanced with the loss of the water supply and costs of treatment, importing water, and establishing another supply if possible.

Furthermore, the balance between individual enterprises and societal needs is an essential component of Danish environmental policy. Tunø is not an exception. For example, even though the banning of fertilizers within the 300m radius zone (approximate zone of influence) would most likely result in the quickest reversal of water quality trends and would lower nitrate levels, this alternative was unacceptable because of its economic impacts to the farmers and the community as a whole. At present, the prevailing farmer working in the 300m zone has created an economic viable leek farm and removal of this land from further production would not be a sound economic response to the situation.

2.2 Tunø History

The island is zoned as an agricultural area with a small area of

summer cottages just south of the Town of Tunø. In addition, there are two small forested areas on the island.

The island of Tunø has a long history of vegetable production as a direct result of its year-round mild climate. Relatively warm air masses from the sea have regulated temperature fluctuations and have created ideal intensive vegetable growing conditions. In addition, Tunø experiences an elongated season.

Water supply history

Tunø contains four water supplies and approximately six drinking water wells. Two supplies are used specifically for agriculture, another (Stenkalven) for the summerhouse area in Løkkegarde, and the final supply is the public system for the Town of Tunø. The Tunø system has one primary well and another well used for summer peak demand.

The Tunø water supply systems first well, B1, was drilled and put on line in 1967. The first water quality tests showed high levels of iron and manganese[b]. In 1978 the second well, B2, was brought on line and from the very first exceeded nitrate standards of 50mg/l. The first test showed a nitrate concentration of 70mg/l. It is unclear why this well was drilled but it is generally believed that an increase in irrigation needs justified a second well. In June 1979 the B2 well had a nitrate level of 105 mg/l and by October 1982 the level was 140mg/l. After 1985 the B2 levels were never below 100mg/l, so the town was granted permission to bring another well, B3, on line in 1985.

B3 was drilled in 1982 and strategically placed at the bottom of the aquifer - just above the clay liner. The B3 well has a pumping capacity of 12m^3/hr.(approximately 100,000m^3/yr), although it actuality pumps about 12,000m^3/yr. In 1992 this well supplied 36

[b]These chemicals are essential components for natural denitrification processes. As iron and manganese levels decrease, corrolarily the soils ability to denitrify decreases.

houses, 4 vegetable farms, 42 summer houses, 4 public institutions (school, Town Hall, and two churches), 1 farm with animals, and 2 hotels for a total of 87 customers.

The B3 was originally (1982), permitted to pump only $5m^3/yr$. This initially low pumping rate was set to minimize the wells cone of influence and not draw down water from the nitrate concentrated aquifer located above it. (The B2 well was located in the center of this aquifer). However, by April 1987, the B1 concentrations were too high to continue use and the B3 pumping rate was increased to ensure adequate supply to the Town of Tunø. As anticipated the nitrate level in B3 rose from 4.5 mg/l in October 1986 to 50 mg/l in April 1987. Until 1989 the nitrate levels in B3 continued to rise approximately 3-5 mg/l/yr. but are currently relatively stable at about 60 mg/l (10mg/l over the accepted standards).

2.3 Methodology

The Protection zone (zone of influence) was determined by pumping rates and available soil data. Consequently, an inner protection zone of 3ha, which was roughly a 100m radius from the B3 wellhead, was bought by the town of Odder for conversion to permanent unfertilized grassland, and an outer zone of 300m, approximately 25 ha., was designated for intensive cultivation control based on nitrate concentrations.

The farmer advisory council and local farmer organization believed that implementation of 'best management practices' and changes to fertilizer application rates would alleviate the high nitrate concentrations. Although, the County of Århus was skeptical, they wanted to cooperate with the farmers and their scientific advisors. In 1989 the farmer advisory council initiated contact with the six farmers located in the outer protection zone. In addition, to implementation of 'best management practices' (e.g. no spreading of manure between October and March, strict controls on fertilizer concentrations, etc.), a specialized fertilizer machine capable of delivering fertilizer doses

at the root level in exact quantities was purchased in June 1989 for the farmers by the Odder Kommune.

However, despite the farmer advisory councils predictions, nitrate levels continued to rise. By 1990 the actual cone of influence had been more accurately defined and data from the monitoring wells showed that the best management practices were not enough to decrease nitrate levels in the soil water let alone the well water. In response, the farmer advisory council and Odder Kommune had intensive discussions in 1990-1991 with the farmers which resulted in the inner zone of permanent grassland being enlarged by an additional 3.5 ha through an elaborate land swap. Furthermore, three fields were voluntarily placed under permanent grassland. Figure 6 depicts current land uses and the cone of influence.

Project area land use

Originally (1987) there are seven land owners and seven active vegetable farms in the project area. Today (1993) there is an extended fallow area and only three active vegetable farms. Table 2 is a breakdown of land uses and agricultural production from 1987-1993.

Although, today, grass is the dominant crop in the cone of influence, leeks are still intensively produced. The fields under production have a rotation of leeks and barley and are never in fallow conditions. Each farmer receives a yearly fertilizer plan for each field from the local farmer advisor. This plan reflects soil conditions, crops, previous production yields, and parcel location. Since, 1989 the fertilizer plans in the zone of influence have also reflected the county's goal to decrease nitrate concentrations in the well. In addition, an unexpected result of the study was to show that over use of the fields had resulted in soil compaction which led to decreased production levels (and increased fertilizer runoff rates). Therefore the yearly, pre-study, increases of fertilizers to the fields would have no affect in crop yields. Since, this data was made available the fertilizer rates have been relatively stable.

Figure 6 Tunø Project Land Uses

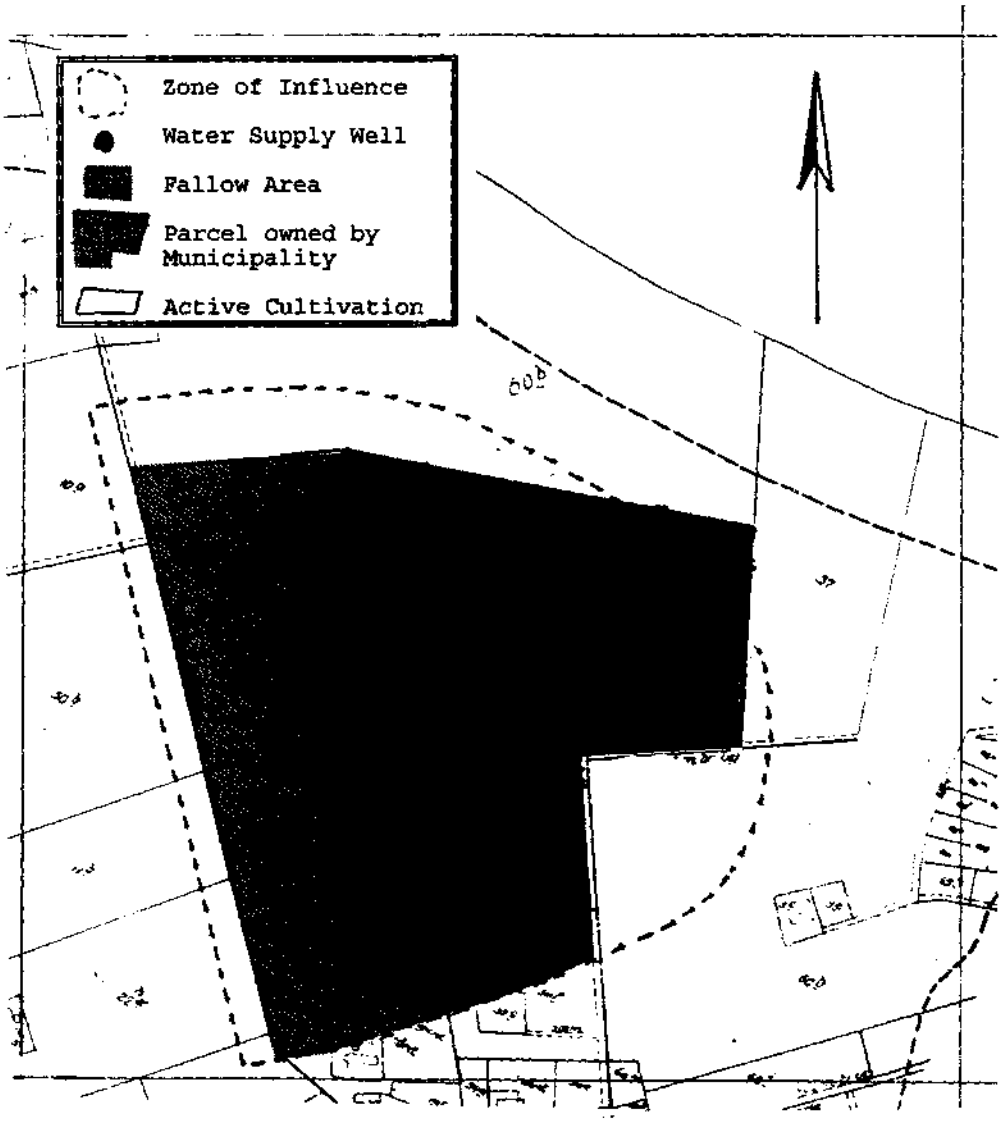


Table 2
Tunø Project Land uses 1987 and 1993

Land Owner	1987 Land Use	1987 % Zone of Influence	1993 Land Use	1993 % Zone of Influence
Oluf Thelgaard	spring barley	30%	fallow- horse pasture	30%
Valdemar Borgaard	spring barley & leeks	37%	spring barley and leeks	12%
Mogens Dejgaard	spring barley	6%	fallow- horse pasture	6%
AArhus Stift-stidend	spring barley	7%	fallow & asparagus (personal use)	7%
Alex Theigård + Johannes Hansen	spring barley & leeks	6%	spring barley & leeks	6%
Ole Olesen (1987) + Odder Kommune (1993)	spring barley & leeks	9%	fallow	34%
Ivan Johansen	spring barley & leeks	4%	spring barley & leeks	4%
Mogens Dejgaard	spring barley	1%	spring barley	1%

2.4 Summary of Findings

Monitoring

Groundwater monitoring wells, soil water monitoring points, and soil nitrate levels have been systematically sampled since February 1989. To date only a few areas are intensively cultivated with leeks within the well's zone of influence. The other parcels the zone of influence are pasture areas for horses which contain a combination of clover and grass.

Monitoring station locations were based upon the assumption that the cone of influence would be symmetrical and the ground water flow was towards the ocean, to the northeast. Therefore, taking account of the presence of the Town of Tunø, the stations were placed radially from the B3 well with an emphasis towards the assumed ground water direction. The soil water monitoring locations are shown on Figure 7.

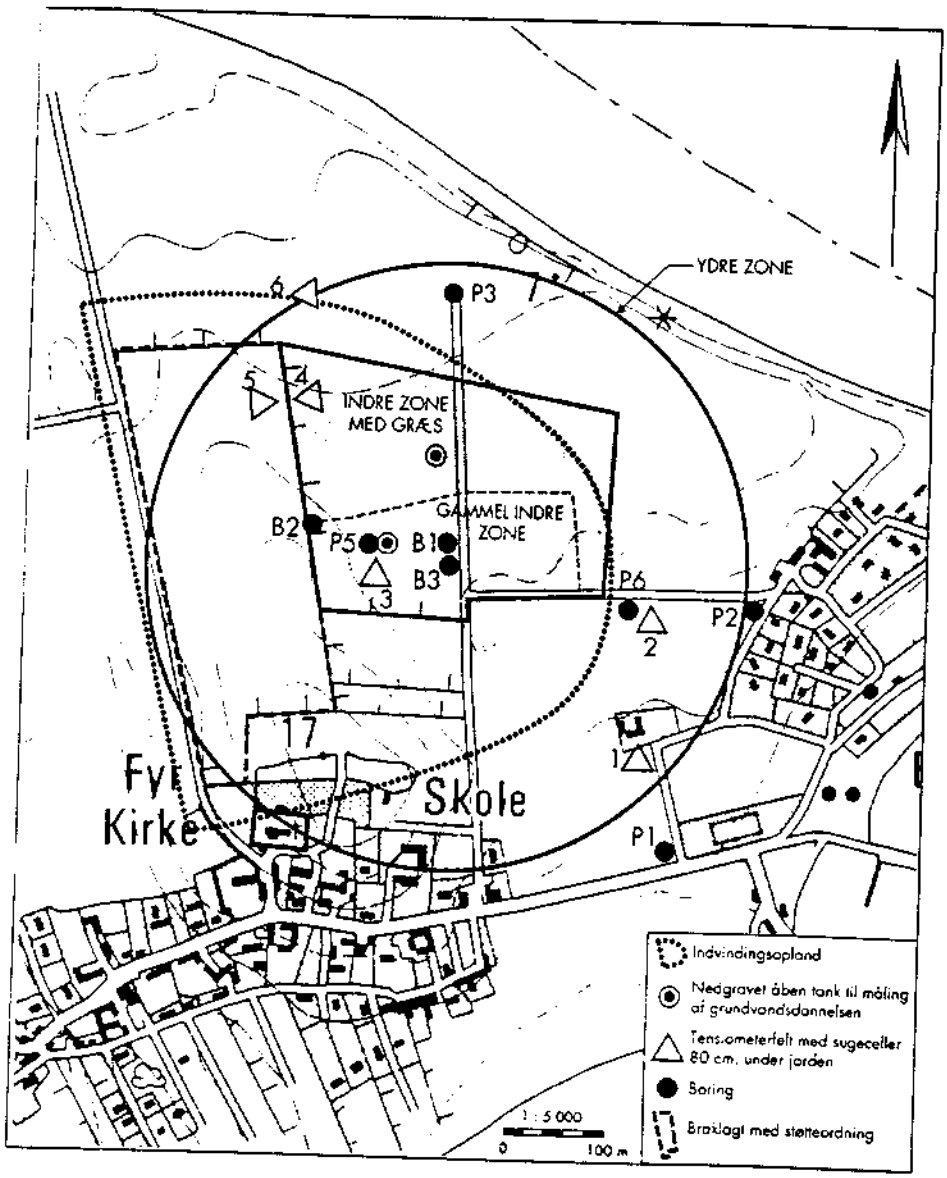
Results

The Tunø project is monitoring soil water, groundwater, and soil nitrate levels in the 300m zone. Although, nitrate levels in the B3 well are not expected to decrease until 1999 (an estimated 10 year soil water movement rate), soil water levels have started to decrease in fallow areas. Currently, the Tunø water quality is relatively stable with 60 mg of nitrate/liter.

The discontinuation of fertilizer applications have a noticeable impact on soil water. As can be seen by Table 2, soil water nitrate levels decrease rapidly decreased in the two soil water monitoring wells numbers 3(♦) and 5(▲). In both cases soil water nitrate levels declined within a year of being placed in fallow conditions.

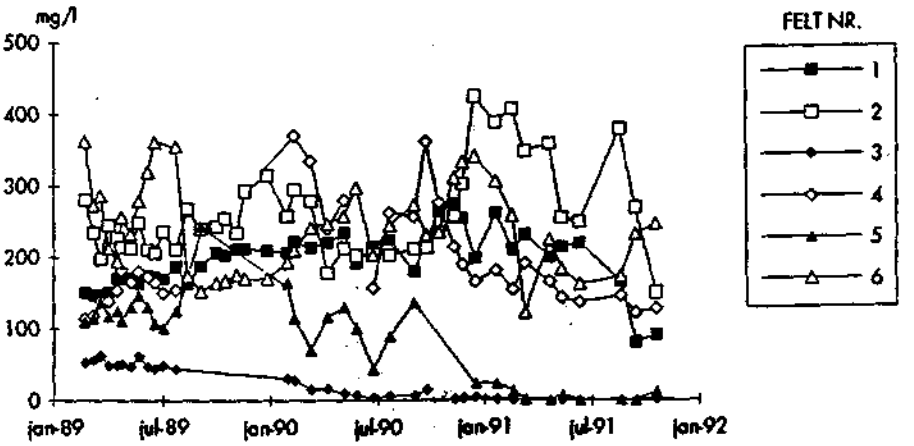
As anticipated by the County of Århus nitrate levels in areas under cultivation remain high. As a result of the early conclusions (1990) and the lack of impact from best management practises the County of Århus and Municipality of Odder purchased additional land for fallow. Station No. 4, located in the expanded fallow area, has also shown the

Figure 7 Tunø Project Monitoring well locations[35]



same nitrate decline trend as seen in soil water stations 3 and 5[36].

Figure 8 Tunø Soil Water Nitrate Concentrations[37]



2.5 Summary and Conclusions

Although, the water quality problems on Tunø appear to be fairly straight forward: one water supply well with high levels of nitrate; one active farmer in the wells recharge zone; and, an apparently strong causal link; solving the nitrate contamination is not as straightforward as it may appear.

Technical Aspects

At the initiation of the study, a few apparently simple technical parameters had to be determined: how much water reaches the well?; what is the nitrate level of the water reaching the well?; where does the well water come from?; how fast will the water reach the well?; and finally, how long will it take to clean the well water?

Hydrological techniques to determine the zone of influence, groundwater sampling, and soil water rate modelling have been used to determine 'best guess' answers to these questions and determine the parameters for protection. However, the Town of Tunø's well, like the majority of Denmark's wells, is located in a hybrid region of clays and sand. The complexity of the soil structure prohibits the calculation of groundwater movement, recharge area determination, and soil water rates without extremely large expenditures of money. Furthermore, the leek production cycle makes fertilizer/nitrate application rates difficult to determine.

Wherever possible, the Århus county has determined every possible parameter and has made "best guess" estimates for the other undefinable parameters. Definitive data include: precipitation/evaporation rates in the area (calculated six times a year); groundwater nitrate levels; soil water nitrate levels, and the laying fallow for one year of land in order to diminish nitrate levels. Estimated data include: the wells zone of influence of approximately 12 ha; a soil water flow rate of 10 years from surface to well; and a fertilizer application rate of 50-100kg N/yr.

Sociological - Economic Aspects

As stated above the general Danish water protection policy is to protect all groundwater so that additional cleaner sources or treatment will not be required within any region of the country. The Tunø study is an attempt by the Århus county to meet this national goal while simultaneously meeting the needs of the local community.

Technical rinsing of groundwater through an ion exchange treatment plant; importing water from off the island; and diluting the existing wells nitrate level with another well, were alternatives to the protection zones study that were analyzed by the Århus county. These alternatives were rejected for economic reasons as well as for not meeting the national objective of preserving groundwater.

Conclusions

The Tunø case study demonstrates the inherent problems water policy strategists face to reverse nitrate leaching. These problems are technical, economic, and political. However, more importantly Tunø demonstrates that intensive vegetable farming and drinking water supplies can not co-exist. Although, definitive data on the wells water quality will not be available until 1997 it can be stated that about 80% of the zone of influence must be placed in fallow conditions to dilute the remaining 20% active farming.

Fallow land designations in zones of influence is not a new concept, (e.g. the Massachusetts regulation of 400' buffer zone from a well head), but has yet to be incorporated into Danish water protection strategies. Danish water policy makers must make some difficult decisions to increase fertilizer-exclusion zones if water supply quality is to be protected. Furthermore, it must be noted that this project only examined impacts to a water supply well and not to the general hydrosphere. If the Danish water policy of protecting all Danish waters is to be accomplished, changes to the agricultural practices are required.

In response to the water quality lessons gleaned from the Tunø project, the County of Århus has initiated another study examining strategies to place active farmland into fallow conditions. Section 3 is a review of the ongoing study to protect water quality and other environmental resources through forestry and open space designations.

SECTION 3: Hadsten - Hornslet Regional Study (Example Project #7)

In response to the new EU set aside requirements, Danish forestry policies, and high nitrate levels observed in groundwater, the County of Århus is conducting a two year study: "Example Project #7" to determine how to best administer each of these separate issues. This study will ascertain farmer's reactions to redesignating agricultural land as forestry or nature preservation areas. The Project has three stated goals: increase forested areas, reduce fertilizer applications in critical groundwater recharge areas, and promote the preservation of nature and cultural heritage areas. The Danish government's policy to double the country's forested land area within the next 70 years and develop wildlife and environmental corridors offers a unique opportunity for regional planners to protect water quality through forestry and open space designations. Furthermore, EU set-aside requirements, and Danish nature preservation programs also provide possibilities for regional planners to successfully satisfy national and international environmental goals simultaneously.

The land use plan is a carefully designed environmentally sensitive blueprint for future development. Implementation of such a plan will only have long term positive economic consequences. However, the realization of this plan requires a national directive, land owner support, or the less attractive eminent domain procedure. The study has been designed to determine how to gain land owner support for such plans.

The Example Project #7 is a coordinated study by the Århus county and the Ministry of the Environment to discover farmer's opinions and reactions to national environmental protection strategies and subsidy programs. The project team's procedure for approaching the approximately 600 farmers will be through the holding of a series of public meetings and the distribution of public notices. The region between Hadsten and Hornslet, has been chosen as the testing area for this project because of its high nitrate levels in groundwater and

intensive pig farming.

3.1 Land Use Designations

The project area, (20,000 ha, approximately 4% of Århus County), is one of the most intensive pig farming area in Denmark. It is primarily zoned for agriculture but contains five urban zones. The county superimposed critical groundwater resources and soil maps to determine areas for forests, afforestation, nature preserve, and/or open space. The natural resource designations are essentially an environmental protection overlay plan which when implemented will satisfy national, regional, and international goals and policies. Areas being targeted within the study are those regions that are highlighted as meeting wildlife corridor criteria (e.g. plant diversity, water systems, migratory pathways, etc.), as well as requiring water quality protection.

The study area is financially funded and endorsed by the Ministry of the Environment because of its integration of the Danish governments' nature preservation policies regarding: forestry, protection of landscape amenity, establishment of nature conservation and cultural heritage areas, highlighting environmentally sensitive areas, and promoting tourism and recreational interests. Furthermore, the land use plan outlines which subsidy programs are applicable for each nature area designation.

3.2 Methodology

Correct strategy for approaching the farmers is essential for project success. The entire project area, has been divided into 10 separate sections and each will be approached separately. The county is hoping that by having numerous small meetings more farmers will participate in the program. A central town within each section has been designated as the headquarters for that section's meetings exhibitions.

Public meeting will commence in February 1994 with a one year timetable for the public participation process. The project team is

expecting to spend approximately one month in each section.

Public Exhibitions

An exhibition depicting the protection plan and explaining project goals and objectives will be displayed in the two local farmer advisor centers, located in the project area. The exhibition will show a map of each section highlighting which farms are to be impacted and a schedule for public meetings.

Public Meeting

Two weeks before the public information meeting is to be held within a section, the project team will send an invitation to attend the meeting to all of the involved farmers and their families. The project team is hoping to attract at least 10-15 farmers from each section. Farmers wives, which are perceived to be more environmentally sensitive, are encouraged to attend the public meeting.

The public meeting will be a "working meeting", where the project team hopes to foster a discussion on the goals and objectives of the project and discuss appropriate protection methodologies. The basic meeting strategy is to start with common ground - 'everyone wants environmental protection whether they are a farmer, a businessman, or a bureaucrat'. The meeting will then progress to a discussion of protection options and methodologies and end with singing old Danish environmental songs. This approach aims at bringing the community together for a common goal. Initial responses to this strategy have proven very effective for the project team meetings with the local government representatives.

Individual Farmer Discussions

The names of farmers interested in the project will be collected at the public meeting and they will be contacted within a week following the public meeting. Representatives of the project team will then organize a visit to the farm and protection options will be further discussed. The county is hoping for an overall participation rate of 10%. This is about 5-10 farmers for each section.

3.3 Summary - Conclusions

Unfortunately, public meetings concerning Example Project #7 had not been started at the time of this writing, therefore, farmer reactions are unknown. Nevertheless, the methodology of granting EU and Danish subsidies through the land use planning process in order to protect water quality can be examined.

The Århus Example Project #7 illustrates the issues Danish planners and policy makers confront in reducing nitrate levels in water. This project demonstrates the need for a careful balance between environmental and economic concerns and psychol - sociological considerations. Farming is the dominate activity within the Århus county where farms and land have been passed down through generations. As a result, the social impact of removing agricultural land from production will not only affect the specific farm but the community and its culture as a whole. In addition, the political repercussions of removing active farmland will be great. As already stated, the project area is the most intensive pig farming area within the entire country and negative reactions would not only affect local politicians, but local approval of the regional plan. In an attempt to remove cultivated land from production in a 'friendly' method, the Århus study exploited subsidy programs. This method is politically palatable as well as non-threatening to farmers.

The success of Example Project #7 is dependant upon farmer cooperation. To date, few farmers have voluntarily entered environmental protection schemes and the County of Århus and the Ministry of the Environment is hoping to ascertain why farmers are reluctant to participate in subsidy programs. Furthermore, they hoped to glean what farmers would suggest as a methodology to protect natural resources and water supplies given the impacts from active farming.

Unfortunately to date the monetary compensation for many subsidy programs has not been enough incentive for farmers to stop intensive agriculture production. For example, forestry subsidy programs

grant aid are based on land designation (areas for afforestation or reforestation) and on the type of trees to be planted (deciduous or coniferous). In the best case scenario where a farmer has a designated reforestation parcel and wants to plant deciduous trees, he will only receive a subsidy of 75% equal to previous earnings and still have to pay taxes on the subsidy. Therefore, the farmer would lose money and would have been financially better off had he continued with existing agricultural practices.

This loss of revenue has been proven to occur in other subsidy programs, for example those for environmental sensitive areas (ESAs). These programs appear to be successful since almost 2/3rds of the ESAs get partial protection, but the program has nevertheless been a waste of money[38]. Many of the farmers entered into ESA agreements for lands on which they were not planning to cultivate or change the existing management practices. Thus, there has been a large expenditure of money to protect land which was not intended to be utilized whereas the compensation to farmers for transforming their prime lands into fallow protected areas was not large enough to entice farmers into participating in the program.

Conclusions

Subsidies as a protection tool

Although economic reasons are seen as the primary cause for the farmer's reluctance to participate in subsidy programs, no supporting data or information has been provided by the Ministry of the Environment to national policy makers.½ The project team is hoping that a total of 60 farmers (10% of the entire study region) will attend the meetings and explain how they feel about the environmental programs and set-aside subsidies offered in the project. The information received by the project team regarding existing environmental programs and subsidies will help policy makers establish new, more appropriate national environmental protection strategies. The County of Århus understands the 'subsidies as a protection tool' drawbacks, but in response asks - what should we due to protect natural resources? The County rightfully believes that this

project establishes a dialogue and creates an ecological strategy which are the first steps to achieving long-term natural resource protection.

However, the study will not address unemployment which is the other critical economic issue associated with subsidy programs. Since, subsidies only help the owner of the land and not the farm workers who would lose their livelihood.

Regional Planners lack of regulatory capabilities

The shortcomings of the volunteer approach to natural resource protection is highlighted in this study. Even though the Århus county has recognized critical water quality zones of influence, cultural heritage areas, wildlife corridors among other natural resources to be protected, it is helpless to implement strong land management regulations. Prohibiting fertilizers in zones of influence will reduce nitrate levels in groundwater supplies, but the counties are unable to take this simple step unless given a national directive. Instead the county must rely on farmer willingness and cooperation.

Coordination between natural resource protection programs

On the other hand, the study's integration of water quality protection and subsidy programs is a welcome shift to a more holistic approach to land use planning. In addition, the coordination between the County, the Ministry of the Environment, and farmer organizations creates a collaboration essential to ensuring environmental policy implementation.

SECTION 4: Conclusions

The Århus study depicts two cases with different approaches to water protection. Although, they have different approaches and methodologies, they are both dependent upon farmer cooperation. As discussed in Part I, the political influence of the farming community is still great and as illustrated in these two studies may override the needs of a community for example, clean water supplies.

The apparently straightforward case on Tunø with one well, one isolated aquifer, and one farmer demonstrates the complexities confronted by water policy planners when implementing water protection strategies. The difficulties faced on Tunø are compounded throughout the rest of Denmark.

On the other hand, Example Project #7 highlights the socio- political factors involved in water protection. Appeasing, local farmers through a voluntary subsidy approach is politically safe as well as supporting personal integrity. However, it has been demonstrated that existing levels of subsidies are not the long term solution to water quality protection. Furthermore, international impacts on Danish subsidy programs, e.g. from GATT, and the EU, may limit the effectiveness of this protection tool in the future.

Although technical and socio-economic issues are critical when determining nitrate reducing strategies, it is essential that the overall goals of national water protection policy be met. The hard choices which have to be made in order to diminish all nitrate runoff into the hydrosphere will require long term visionary policies. As seen in the County of Århus, policy makers will have to start asking themselves the important question of "when do the needs of the community outweigh one person's economic and social well-being?".

Given the lessons from these two studies the Århus water protection zoning strategy is perplexing. Tunø clearly showed that a 10m zone was not enough to decrease groundwater nitrate levels and a minimum

of a 300m zone was required to reduce nitrate concentrations if vegetable farming is involved. The proposed Zone 2 'hygienic zone', may or may not ban the use of fertilizers. *If* this zone prohibits fertilizers and *if* the county can get some legal clout to enforce this strategy than nitrate levels could decrease. Given the 100's of wells in the county, and the amount of land to be removed from agriculture production, prohibition of fertilizers in Zone 2 seems unlikely. Furthermore, given the careful strategic planning associated with approaching farmers with subsidies in the Example project 7 this method may be very difficult to implement. On the other hand, this methodology is a starting point for establishing water protection goals and land owner discussions.

Unfortunately given the Tunø example water protection appears to be a 'clean water or farms' dichotomy regarding agriculture. Other, less harsh solutions need to be evaluated, e.g. organic farming. But until an alternative farming practice can be developed, which does not have adverse impacts on the hydrosphere regional planners, it is essential regional planners have the appropriate legal capabilities to meet their water quality mandate.

PART III: DANISH ENVIRONMENTAL POLICY CONCLUSIONS

The Danish national environmental policy implementation strategy based on the physical planning system is an innovative method for integrating social, political, economic, and environmental issues. Yet, the system is unable to meet all of the national, international, and regional/local environmental protection requirements. The ineffectiveness of this system is clearly depicted in the country's inability to reverse nitrate contamination due to agricultural practices. As a result of this failure Denmark is the second worst nitrate polluted country in the world.

Nitrate pollution of the Danish hydrosphere is primarily the result of agricultural practices. Therefore, cleanup, preservation and protection of the hydrosphere requires the cooperation of the agricultural sector. However, economic, political, historical, and geographic factors create a myriad of complex problems which Danish water protection planners confront when developing policies related to agricultural practices. This complexity has effectively blocked Danish water policy implementation over the past two decades.

The overall aim of the Danish water protection policy is to protect all groundwater so that additional cleaner water sources or treatment of existing supplies will not be required in any region of the country. Furthermore, its objective is to bring all water e.g. surface, coastal, groundwater into compliance with Danish and European Union (EU) water quality regulations without the need for treatment. These goals and policies are implemented through the regional and local planning processes. Regional councils are responsible for establishing water quality standards to achieve national goals while also reflecting local

geographic, economic, and political conditions. In spite of the innovative quality of this decentralized system, the regional councils are unable to adequately protect, preserve, and enhance water quality for a variety of geographic, political, and socio-economic reasons.

Geographic Issues

Denmark is a hybrid of sand and clay soils with one dominate land use - agriculture. The nature of the soils has traditionally required Danish farmers to add a lot of fertilizers (natural and chemical) to attain production and profit quotas. As a result, large quantities of nitrate from fertilizers have leached into the Danish hydrosphere causing widespread eutrophication and elevated nitrate levels in groundwater supplies. In addition, 64% of Denmark is cultivated. There are over 4,500 water supply wells, 7,300 KM of coastline, and 64,000 ha of rivers, streams, and lakes - thus there is an extensive water quality crisis.

Danish geographic factors require that changes be made to existing fertilization practices and the water policy implementation processes, in order to satisfy the Danish water policy goal which is: quality preservation without treatment. Mechanisms aimed at amending the existing system, for instance through the implementation of 'best management' fertilizer application practices, have been demonstrated to be ineffective in reversing poor water quality. The case study on the island of Tunø (Part II: Section 2) showed that current farming practices cannot continue if water quality goals are to be obtained.

Political Issues

The Danish welfare state, was brought about by the strong socially conscious middle class which emerged from historical educational and agrarian reforms of the nineteenth century. It is characterized by its democratic orientation, redistribution of profits, and policy implementation through decentralized democratic processes.

Danish environmental laws and regulations are written and implemented through a process of negotiation resolution. Popular movements

are regularly consulted when legislation is prepared and interest groups are represented on the boards of administrative agencies. The Danish legislative process follows the German method of a flexible framework. Laws are not 'black and white', but are open for interpretation. Even though, this system allows great implementation flexibility, numerous national standards are firmly set to ensure adequate environmental protection. Each municipality and county is therefore able of respond to local conditions in their interpretation of the environmental laws and regulations. This decentralized, open implementation process offers great flexibility to meet the objectives of legislation but it also can give too much influence to special interest groups in the local communities.

Political aspects of water protection strategies have an impact on national, regional, and local governments. Due to its pre WWII economic and political influence, the agriculture sector has been able to continue to manipulate and influence public policy. As a result of Danish geography, any water protection strategy and nitrate reduction scheme will directly affect agricultural practices. Legislation and regulations which would have a strong impact on agricultural practices, and which are therefore perceived as negative, are considered political suicide. Furthermore, political parties which are aligned with the farmers interests, e.g. Venstre, have established policies to not support legislation which would cause hardships to the agriculture sector. Therefore, many water protection strategies, such as land taking, fertilizer taxes, non-fertilizer zones are not supported or approved in Parliament.

Unemployment rates, agricultural subsidies, agricultural lobbies, national character issues are other important aspects which must be addressed together with other technical and environmental issues in an integrated water protection strategy. In addition, noticeable reductions in nitrate levels will take 10-20 years before they become noticeable. Politicians (and political parties) who need to be re-elected every four years are therefore wary of making the difficult choice of regulating the agriculture sector.

Regional plans which are the Danish tools for implementation of water quality objectives must be accepted by elected regional councils. Regional plans are therefore often a negotiated political compromise at the detriment to water quality. If regional councils are to protect natural resource, then new legislation granting autonomous powers to the counties is needed.

Sociological - Economic Issues

In addition to satisfying national water quality goals and policies, regional councils must also meet local economic, social, and geographic requirements. The case study of the county of Århus's water protection strategy highlights the careful balance regional planners must achieve when determining land use designations and setting emission and withdrawal standards.

For example, the county hopes to achieve national environmental goals without causing negative economic impact to existing businesses. Example Project #7 (Part II: Section 3) utilizes optional subsidy programs as a natural resource protection tool. Although this approach is sociologically acceptable to the farming community because it preserves individual integrity allowing the farmer to continue controlling production, it might not turn out to be very effective.

Economic interests must also be taken into account by water policy planners when determining strategies. Technical rinsing of groundwater through an ion exchange treatment plant; importing water from other areas via pipes, and diluting the existing wells nitrate level with another well, are alternatives for improving r drinking supplies, but are rejected by local water quality planners for economic reasons. They also do not meet the national objective of preserving groundwater quality or address the problems of surface runoff into surface and coastal waters.

The Århus case study epitomizes how regional and local planners must provide water protection strategies that simultaneously meet

national and regional water policies as well as supporting local and regional economic and social needs. Århus also demonstrates why regional planners are unable to satisfy these various requirements. Even though, regional planners are responsible for implementation they do not have the legal authority to establish land use management practices or designate land uses. In other words, which land should be set-aside to meet EU requirements? Legislative changes aimed at natural resource protection is needed if Danish water policies are to be realized.

SECTION 1: OTHER WATER PROTECTION METHODOLOGIES

As stated above, the Danish water policy implementation system is not working. New alternative methodologies reflecting the unique Danish social, political, and geographic factors are needed. Granting regional councils legal autonomy and new land use legislation are two legislative solutions. Creating a national park system and revamping the agricultural production processes are long term visionary solutions. Each of these methodologies will help alleviate the water crises in Denmark, but a combination of all four would be best.

New Legislation

Although, each of the methodologies presented will require new legislation from Parliament, specific land use legislation is essential to meet national water policy goals.

Overlay Zones

Existing land use zones (urban, rural, and summer-house) do not account for the intricate natural resource systems. New zones focused on national environmental policies would give regional and local planners increased versatility to implement environmental policies. For example, the government wants to double the forested area within the country, yet a forestry land use zone does not exist so planners have to negotiate with rurally zoned land owners to meet this objective. A forestry zone would help achieve the national goal through the land use planning processes.

Other natural resource overlay zones that are needed include: aquifer zones, environmental sensitive areas, wildlife corridors, open spaces, cultural heritage areas, etc. These overlay land use designations would give regional and local planners the tools they need to manage land uses in such a way as to meet national environmental policies.

Set-aside parcelling coordination

Another, essential piece of legislation is the EU set-aside process. Currently set-aside decisions are voluntary. Coordinated set-asides

would assist regional planners in complying with national requirements. Design of set-aside can simultaneously meet EU requirements and national water, cultural heritage, and forestry policies. The existing haphazard volunteer approach will probably not accomplish any of the natural resource policies. Example Project #7 depicts an approach designed to set-aside requirements.

Regional Authority

As shown by the Århus case study, regional planners have inadequate authority to meet national water policy goals. Regional environmental implementation is completely dependent upon land owners (farmer) volunteering to participate. It is impossible for regional planners to satisfy local economic and political needs while simultaneously protecting water quality. Legislation aimed at granting regional counties legal authority to implement land use plans is needed.

Regional council empowered with legal authority will be able to effectively implement the regional plans and policies. The need of the community will outweigh the need of the individual, as was not the case in the Tunø example. The political ramifications of water policies would be removed from the process and appropriate land use designations and standards would be implemented to meet the nation water quality goals.

National Parks

Increased public ownership of land is essential to fulfill national water policies. The Tunø case study demonstrated the need for public ownership combined with volunteer fallow lands to adequately dilute nitrate leaching in the water supply well. Subsidy programs contain a twenty year fallow land requirement. If long term water protection is to succeed - it is essential that land be allowed to remain fallow for an undetermined period. Therefor, public ownership is the only economically and socially acceptable solution.

Alternative (organic) farming system

The only comprehensive solution to the Danish nitrate leaching

impacts on water quality is to restructure the entire agricultural production system. It has become clear that the entire Danish agricultural sector must adapt its production processes to reverse negative water quality impacts. Danish farmers have a history of farsightedness, versatility and responsiveness to changing environmental, economic, and social needs. The complete reorganization and alteration of Danish farming between 1860 an 1900 attest to this. Similar market and economic factors exist in Denmark today. The specific issues facing Danish farmers today include: nitrate runoff from their fields and the associated impacts on water quality; pressures and regulations from the EU (Common agricultural policy) and the Danish government on set-asides and production quotas; and, the challenge of remaining a viable industry not relying on many governmental subsidies.

A solution to these pressures must found that accounts for the economic, political, and geographic realities of Denmark. Overhauling the entire agricultural sector to bring in organic farming and re-marketing all Danish produce as organically grown could satisfy all of these issues. Organic farming in Denmark would simultaneously, decrease nitrate runoffs to the water courses and allow the inner coastal waters to rejuvenate. This in turn would help the flagging fishing industry. It would also allow the country to meet all the EU and Danish agricultural and environmental policies; and, allow the farmers to farm thereby protecting their cultural heritage and rural employment.

Organic farming produce needs proper marketing to become a viable enterprise. Recent trends of consumer preferences towards healthier and environmentally sensitive foods can be capitalize on by Danish farmers. No country has cornered this new growing market - and Denmark could once again become an agricultural leader if it exploited this niche.

Hesitation towards organic production centers on farmer equipment debts still owed on farm equipment and the need to meet mortgage

and loan payments. It has even been demonstrated that it would be cheaper in the long run to have no farming in Denmark[39]. When costs for set-aside subsidies, water treatment, health impacts from elevated nitrate levels, economic impacts associated with a smaller fishing industry, are taken into the equation it becomes fairly obvious that the cost to sustain an industry that only provide 10% of GNP are totally out of balance.

As it has already been stated, Danish politicians are wary of the agricultural sector when establishing economic and environmental policies. To date, politicians have not embraced the organic solution because of lack of support from the agricultural sector. However, it is the authors belief that if adequate debt re-payments scheme instead of set-aside subsidies were offered to farmers then the agriculture sector as well as the general public would be supportive.

SECTION 3: NEW DIRECTIONS

There are two distinct problems in cleaning-up nitrate leaching in Denmark: technical and political. To date, Danish efforts have been aimed at the technical questions involved, for instance, denitrification processes, impacts of catch crops, sandy versus clayey soil leachate rates, precipitation impacts, nitrate modeling, etc,. But as demonstrated, the complexities of calculating nitrate leaching rates could continue well into the next century and still not produce conclusive irrefutable evidence. Simultaneously, the nitrate levels in groundwater will continue to rise as will the rate of eutrophication.

On the other hand, the political aspects of nitrate leaching and general environmental policy implementation have yet to be appropriately accounted for in protection strategies. (Unless inaction is a strategy.) It has been proven beyond doubt by a majority of tests that farming practices are the main source of nitrate to the Danish hydrosphere-even though some agriculture scientist refute these conclusions. So why haven't the Danish policy makers taken appropriate steps to control this pollution source as they did with industrial discharges in the 1970's? Obviously, the lack of regulations is political stalling. But it is too easy to attribute the lack of action to politics alone. The Danish culture and its reverence towards farming is as much to blame.

Danish policy makers and the general public need to take off their rose-colored glasses and bring the agriculture sector under control. Continued testing will not solve the problem. The time for clear far-sighted policy has come. Other sectors which have an even higher economic stake (tourism, industry, and fishing) need to rally and press politicians into passing new regulations and establish land use controls to stop the nitrate pollution. Politicians will always be nervous at election time. Nevertheless the time has more than come for them to implement visionary economic and environmentally appropriate national policies.

NOTES

1.Helge S. Jacobsen, *An Outline History of Denmark*, p.9.

2.Ministry of the Environment, *Denmark National Report to UNECD*, p. 74.

3.Agriculture Council of Denmark, *Agriculture in Denmark*, p.210.

4. Helge Jacobsen, *An Outline History of Denmark*

5.Brian Fullerton and Richard Knowles, *Scandinavia*, p.108.

6.Kramp, *An Agriculture Geography of Denmark*, p.11

7.Agricluture Council of Denmark, *Agriculture in Denmark*, p.10.

8. Ministry of the Environment, *Environmnetal Impacts of Nutrient Emmissions in Denmark*, ch. 3.

9.Ibid., ch.2.

10.Ibid., p.18.

11.Ibid., p.45.

12.Ministry of the Environment, *State of the Environment in Denmark*, p.81.

13.Ministry of the Environment, *Environmental Impacts of Nutrient Emissions in Denmark*, p.20.

14.Ibid., p.82.

15.Ministry of the Environment, *Environmental Impacts of Nutrient Emmissions in Denmark*, p.61.

16.Ibid., p.64.

17.Ibid., p.172.

18.Brian Fullerton and Richard Knowles, *Scandinavia*, p.14.

19.Sten Vallig, Professor, University of Copenhagen course on "Urban Challanges", February 15, 1993.

20.Agriculture Council of Denmark, *Agriculture in Denmark*, p.211.

21.Ibid., p. 216.

22.Kramp, *An Agriculture Geography of Denmark*, p.11.

23.Author's interview with environmental law master student Lone Jensen March 1, 1993. Jensen had just recently completed Master's Thesis on environemntal policy and law, University of Århus.

24.Ministry of the Environment, *Environmental Protection Act, No. 358 of June 6 1991.*

25.Ministry of the Environment, *Water Supply Act, Act No 299 of the 8th of June 1978.*

26.Kerndal-Hansen, *Planning in Europe*, p.118.

27.Author's interview with Danish national planner, Fritz Larsen in November 1992.

28.Strudsholt and Hvidtfelt, "National and Regional Planning in Denmark", *Interplan*, No. 3, 1990.

29.Ministry of the Environment, *Denmark National Report to UNECD 1992*, p.76.

30.Author's interview with Århus County Planner Søren Lave in April 1993. Lave is responsible for coordinating the 1997 Regional Plan.

31.Author's interview with the Århus County Groundwater Department Director Head, Richard Thomsen in September 1993.

32.Richard Thomsen, "Kortlægning og Overvågning af Grundvandet", in *Grundvand og Drikkevand i Århus Kommune*, Aug. 1993,

33.Jørgen Primdahl, " Agriculture in Environmentally Sensitive Areas: Implementing the ESA Measures in Denmark", *Journal of Environmental Management and Planning, 36*(2), 1993.

34.Ministry of the Environmnet, *Acts of Forests - Denmark.*

35.Århus Amt Miljøkontoret, *Tunø StatusRapport 1991*, p.10

36.Ibid., p.21.

37.Unpublished data collected by the Århus Groundwater department in November 1993. (see Lærke Thorling for details and copies).

38.Ibid.

39.Niels Groes, *Brug og Misbrug Studier i Anvendelsen af Danmarks Jord* [A study on Use and Abuse of Danish Land] .

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